ELECTRICAL ENGINEERING

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SEPTEMBER
1952

The Cover: Some of the outstanding events of the Centennial of Engineering will center about the Museum of Science and Industry in Chicago, Ill. Here, unique exhibits, demonstrating the basic principles of many industrial processes, are installed. "Adam to Atom," a stage production dramatizing America's industrial growth, will be presented daily in the Museum theater.

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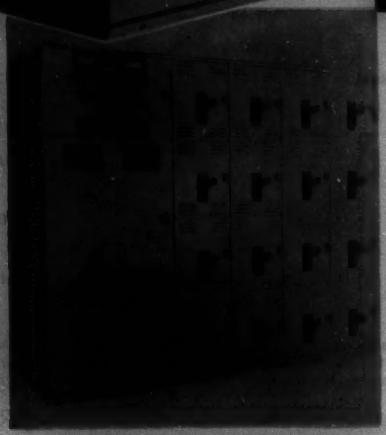

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HIGHLIGHTS .....

Board of Directors' Report. Full text of the 68th annual report of the AIEE Board of Directors is included in this issue. It contains a brief summary of the principal activities of the Institute during the year ending April 30, 1952, a general balance sheet showing the financial condition of the Institute at the close of the fiscal year, a statement of cash receipts and disbursements, and a schedule of securities owned (*pages 823–51*). In addition, this year a series of graphs have been prepared which illustrate the tremendous growth and expansion of the Institute during the past 11 years. This growth is reflected not only in the membership statistics, but in the expanded technical organization, the increased attendance at meetings, and the increase in the number of both technical and conference papers (*pages 821–2*).

Officers and Committees. With the beginning of a new Institute year, a complete listing of AIEE officers, committee personnel, and representatives for 1952–53 is presented in this issue (*pages 851–62*).

Prize Rules for Technical Papers. Announcement has been made of a revision of the rules for the award of prizes for AIEE technical papers. These rules originally were approved by the Board of Directors on June 23, 1949, and were revised on June 26, 1952. The rules cover eligibility, entrance requirements, and basis of grading, and summarize the various awards available each year in each classification (*page 815*).

Coming Events. A full program of activity is in store for engineers this fall, beginning with the Convocation of the Centennial of Engineering which is expected to attract engineers from all parts of the world to Chicago this month. The Centennial commemorates the first 100 years of organized engineering activity (*page 817*). Also scheduled for September is the Instrument Society of America's exhibit in Cleveland, Ohio. The AIEE will participate with two technical sessions (*page 818*). The eighth National Electronics Conference will meet in Chicago, September 29–October 1, with the AIEE as one of its sponsors. The program will offer some 99 papers, supplemented by more than 75 exhibits (*pages 816–17*). With New Orleans as its host city, the AIEE Fall General Meeting will be held October 13–17. In addition to a full week of technical sessions, the meeting will feature a varied social program for both the members and their ladies, and a number of inspection trips to points of interest in and around New Orleans (*pages 813–14, 816*).

Letters of Alessandro Volta. Living as he did in an age when letter writing was the accepted method of announcing a new discovery or theory, most of Volta's scientific activities are recorded in his letters. However, the human content of these letters is perhaps even more fascinating than the purely scientific content (*pages 773–6*).

Automatic Switching for Nation-wide Telephone Service. In this first of a series of four articles on the plan for automatic long-distance telephone service, which will embrace the entire United States and extend into Canada, a general outline of the plan is presented and some of the problems which have arisen and have been overcome are explained (*pages 780–3*).

Fundamental Plans for Toll Telephone Plant. The general switching plan and fundamental plant layout proposed for handling telephone toll messages throughout the United States and Canada using automatic toll switching are explained in this second of a series of four articles on nation-wide telephone service (*pages 785–91*).

Ultrathin Magnetic Alloy Tapes With Rectangular Hysteresis Loops. The magnetic properties of toroidal cores wound from these tapes were studied using d-c magnetization. Though the coercive force tends to increase with reduced thickness, their coercivity is usually lower than that of ferrites or powdered metals (*pages 792–5*).

Synchronous Condenser Operation of Southern California Edison Company. This large 220-kv transmission system with 1,765 circuit-miles services central and southern California as well as southern Nevada. It utilizes synchronous condensers to control transmission system voltage and help supply the 3/4 megavar needed per megawatt of peak system load (*pages 803–06*).

New Aircraft Electric System Circuit Breaker. A discussion of a circuit breaker with ratings up to 125 amperes, 120 volts, alternating or direct current is presented in this article (*pages 776–9*).

MONECA—A New Network Calculator. MONECA was developed to reduce the time taken to perform calculations on single-phase induction motors. It is based on a new revolving-field equivalent-circuit, but it can be readily reconnected for many different circuits (*pages 795–801*).

Holland's Electrified Railways. War damage gave this country an opportunity to re-evaluate and change its power supply system, but the former system seemed best after careful study. This article describes the rehabilitation and improvements in the railroads since 1945 which have been so impressive that today Holland has one of the best 1,500-volt d-c systems in the world (*pages 806–12*).

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Bimonthly Publications

The first issues of the new bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, have been released. Superseding the AIEE *Proceedings*, these publications contain the formally reviewed and approved numbered papers (exclusive of ACO's) presented at General and District Meetings. The publications are on an annual subscription basis. In consideration of payment of dues, members may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts allowed to libraries and publishers and subscription agencies.

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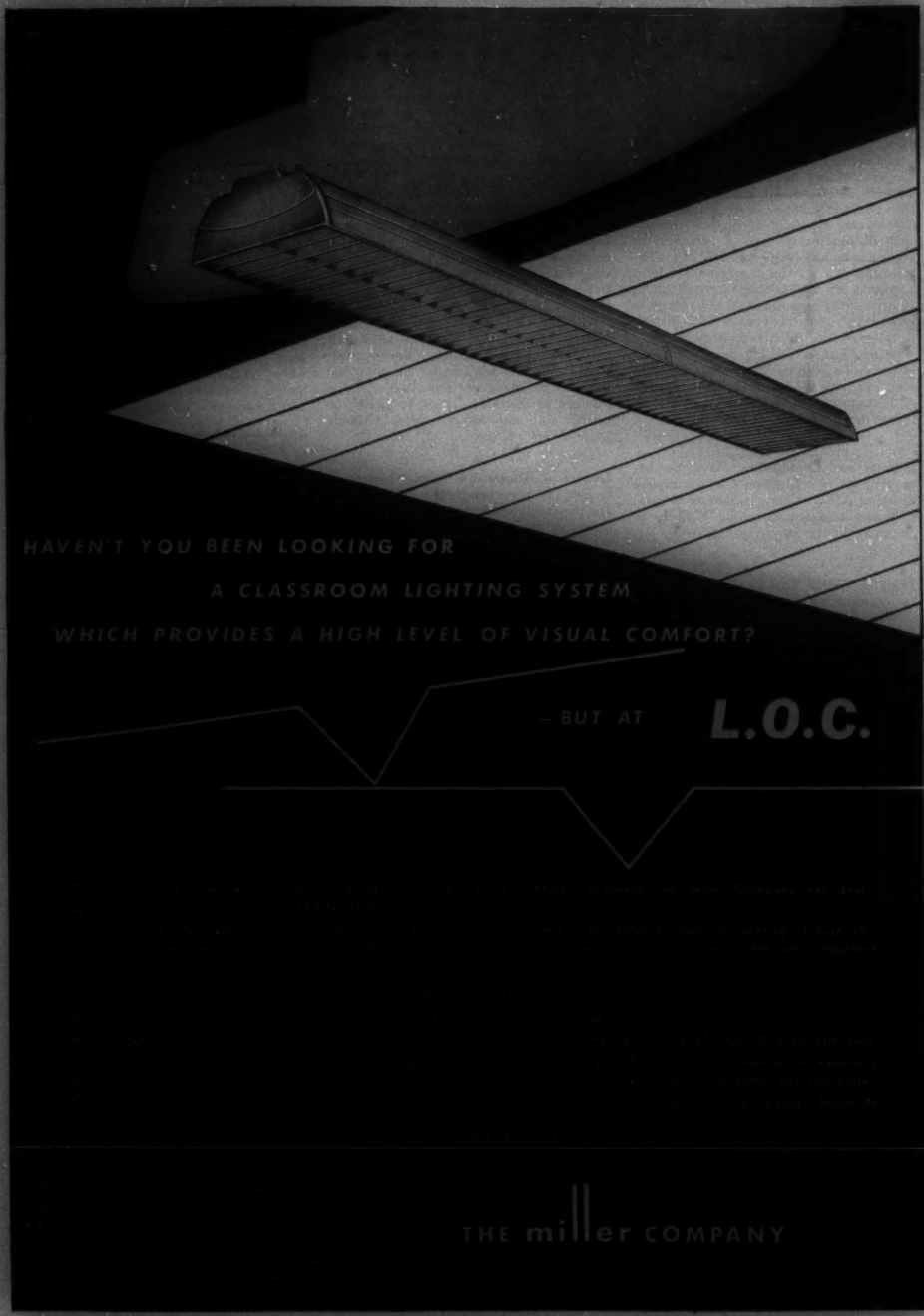
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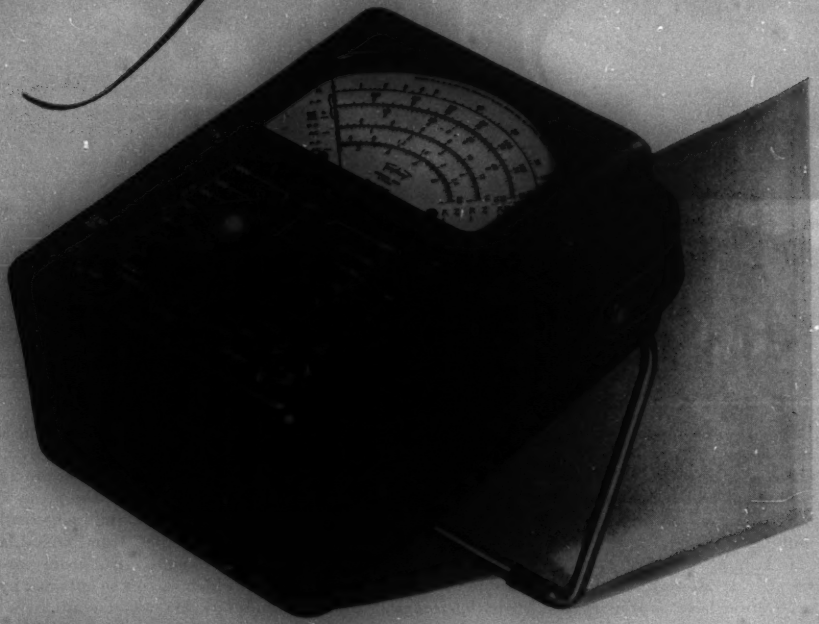

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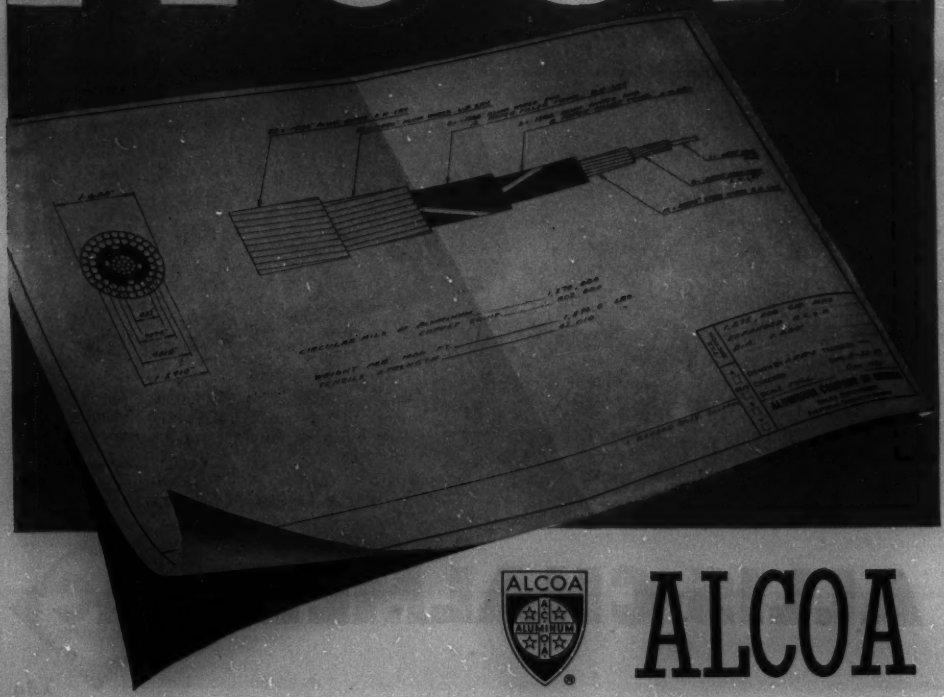

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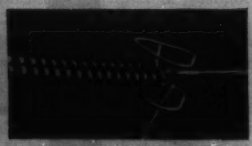

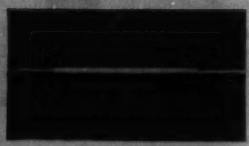

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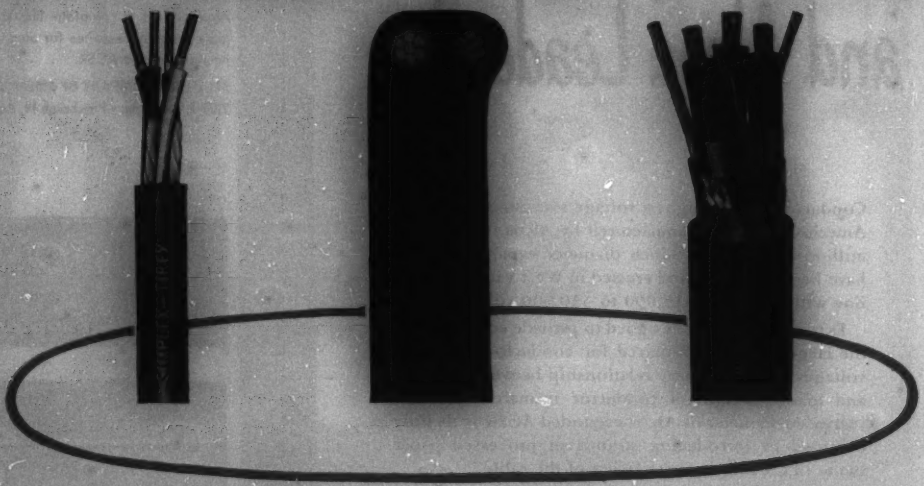

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The Letters of Alessandro Volta

P. A. ABETTI
ASSOCIATE MEMBER AIEE

In accordance with the custom of his era, most of Alessandro Volta's scientific discoveries and activities are described in his letters—to societies, to his friends, and to his fellow scientists. As a contrast to today's impersonal technical articles, however, these letters go beyond the mere presentation of scientific information to give us an insight into the character and personality of the man himself.

ALESSANDRO VOLTA (1745–1827) gave to mankind the first practical source of electric current in his battery, or voltaic pile. He announced this epoch-making discovery in a famous letter addressed to Sir Joseph Banks, president of the Royal Society in London, England, dated from Como, Italy, March 20, 1800. Volta's letter was read before the Royal Society on June 26, of the same year. It was published at once in French, as originally written by Volta, in the *Philosophical Transactions* of the same society for 1800, with the title, "On the Electricity Excited by Mere Contact of Conducting Substances of Different Kinds. In a letter from Mr. Alexander Volta, F.R.S., Professor of Natural Philosophy in the University of Pavia, to the Right Hon. Sir Joseph Banks, Bart. K.B.P.R.S." It was published the same year in English translation in the September issue of the *Philosophical Magazine*.

This letter, as Payson Jones writes,[1] created "a terrific sensation" and started a whole series of discoveries, so that 100 years later Sir John Fleming referred to the voltaic pile as "an invention epoch-making in the history of the world, a landmark in the intellectual record of the race," since Volta's battery was "the first practical means for generating a continuous electric current."

Almost all of Volta's discoveries and scientific activities are recorded in his letters, which thus are invaluable for the history of science and of human achievements in general. The epistolary of Alessandro Volta is now being published in Italy in a complete and definitive edition.[2] Two volumes have appeared so far, three more will follow, and the entire work will contain 1,663 of Volta's letters to learned societies, to scientists throughout the world, to his family, to his friends, and even to a beloved woman friend.

A first glance at any of these large volumes inevitably will raise the question in the reader's mind: Why did Volta write so many letters, especially on scientific subjects? The most obvious answer to this question is that letter writing was a custom and an art of the times in which Volta lived. Another answer, which requires some study of the epistolary, is that Volta actually found enjoyment in letter writing, so that some of his letters are outstanding not only for their scientific content, but also for their exquisite literary form.

In the 17th century letters represented the chosen means of scientific intercourse in Europe. Galileo announced his most famous astronomical discoveries in letters to other astronomers such as Kepler, or to his friends and protectors. In those times such letters, wisely addressed to some leading personality in the field, were circulated widely through the learned circles of Europe. Announcement in such manner of a discovery or of a new theory corresponded to publication. Volta finds himself at the end of this "epistolary age," which soon yielded to publication of papers in scientific magazines and journals in France, England, and Germany, where scientific academies flourished. However, this change did not happen so quickly in Italy, where the academies were declining, or lacking altogether.

Letter writing was far better suited to Volta's character than the composition of a scientific paper. Polvani brilliantly remarks[3] that Volta had a "volcanic" mind. Volta, in fact, wrote to Castelli "thousand and thousand ideas are boiling inside my head." His soul was exuberant, his spirit daring, and he felt that the familiar surroundings of his family, of his school, of his home town, were too narrow for him. Letters allowed him to pass beyond the city walls, the Alps, and even the Atlantic Ocean. He wrote on many subjects to Beccaria in Turin, to Priestley in England, to Nollet and Lavoisier in France, to Lichtenberg in Germany, to Benjamin Franklin in America. Volta exchanged ideas with these masters of the young electrical science. When he was only 18 years of age, in 1763, he wanted to show that all electric forces followed Newton's law, just as the gravitational forces. From France, Nollet answered, "Nobody ever dared to attempt this," but added, "it will be a great glory if you achieve this."

Volta's scientific letters are in general extremely clear. To our tastes they may appear lengthy, although not prolix. In fact, no editor compelled him to "boil down" his ideas to a few pages. Their greatest charm lies in the extraordinarily simple presentation of the contents, in the familiar conversational tone, as in a talk between two friends. For instance, the letter of June 10, 1775, to Priestley which describes the newly discovered electrophorus is sincere, vivacious, happy, full of enthusiasm.

"I do not know whether I should expect that my observations will be welcome and interesting to you, rather than importune. By saying that these are my discoveries, it may be that I will remain once more deluded, as with my

P. A. Abetti is with the General Electric Company, Pittsfield, Mass.

The author acknowledges the assistance of Professor Giorgio Abetti of Florence, Italy, member of the National Commission for editing Volta's works.

previous observations on burnt wood. In fact, your excellent 'History of Electricity' advised me, although too late, that these observations on burnt wood had been made previously in part by others. Well, who knows whether the continuation which you are planning for the same History will not come to deprive me in the same manner of the happy illusion of these new presumed discoveries. Whatever the outcome may be, I have no reason to be less grateful to the teachings of your History for this clarification, and for the knowledge it will give to me. However, I will be a thousand times more grateful to you if you will tell me at once candidly: 1. what place and part I may safely attribute to myself in the discovery of facts which appeared to me, and 2. the value which yourself give to this discovery."

Alessandro Volta

After this introduction, wherein modesty tempers the inventor's pride, Volta proceeds to describe in detail the electrophorus. He gives good practical advice to his readers, and no information essential for the building and operation of the instrument is omitted or concealed.

"I present to you a body which, electrified only once and for a short time and not strongly, will never more lose its electricity, and will obstinately maintain the live force of its indications, even if it is touched again and again . . . . I have a tin plate with the edge raised a little more than a half inch, and a foot in diameter. Inside the plate I have a melted mixture made of turpentine, rosin, and wax which has been flattened and hardened into a brilliant hard surface. I have several other of these apparatus, larger ones and smaller ones, even some of wood, which have a lead sheath stuck to the bottom, and wherein I have poured sulphur, sealing wax, and other mixtures of various composition. However, I have found that the mixture mentioned above is the best and most convenient. I make it of three parts of turpentine, two of rosin, and one of wax, all boiled together for several hours. Finally I add some red lead, in order to give a bright color to the mixture.

"As an upper armature, I use a piece of gilded wood, in the shape of a shield about 10 inches in diameter, about 2 inches high, flat on the base which must come into close contact with the mixture, but convex on its sides or edge. From the center of the concavity rises a handle of wood, or better still of sealing wax, well polished, with its edges well rounded (this is very important). I will, therefore, call this armature a shield. I believe it superfluous to advise you that I ordinarily use a shield of gilded wood, because it is less expensive, lighter, and easier to manage than a shield made entirely of metal. Nonetheless, I thought later of making another shield of brass, all hollow inside in the shape of a box, which I use for a smaller apparatus to be kept in my pocket. I find that this new shield presents several advantages. One essential advantage is that it is well polished, and therefore dissipates less electricity. The other advantages are only with respect to appearance and convenience. For instance, the noise of even the weakest sparks can be heard well. Several instruments commonly used may be kept in the new shield, as little bottles, insulating handles, balls, strings, and such like . . .

"—Here then, sir, is the instrument, so let us try it out and see if the effects correspond to our assumptions. . . .

—"But the indications become weaker as time goes on?

—"Surely, especially if you keep on playing with the instrument often and for long times.

—"Then the indications will vanish altogether?

—"Yes, perhaps that will happen. I do not know after how much time. But what will you say if I cause the indications to increase?"

And the letter proceeds as a conversation between two good friends, Volta and Priestley. In closing, the satisfaction of being a successful inventor again appears in words full of sincerity and enthusiasm:

"I cannot end this discussion . . . without saying that, although this discovery is nothing more than a consequence of the theory which caused me to imagine this apparatus, nonetheless it appears very marvelous to those who are not very familiar with such matters. I will also confess that I personally was full of happiness as I saw the facts respond completely to the conceived ideas. I was happy for the beautiful harmony which I observed between the principles and the results, and also for the resulting surprising novelty with its great practical advantages."

The theory of the electrophorus is given in full in the second part of a long letter which was published in the original Italian version in the *Philosophical Transactions* of the Royal Society of London, after being read on March 14, 1782, before this society.

Volta's most famous letter, mentioned at the beginning of this article, describes the electric battery. According to Polvani,[2] an authority on Volta's work, this letter is quite different from all others. First of all, no hint is

given of the mental and experimental processes which led Volta to the discovery. The relationship between the voltaic pile and Volta's previous work is not even mentioned. Most strange is the unexpected fact that Volta presents the battery, the "artificial electric organ" as he called it, as the reconstruction of the "natural electric organ" of the electric eel. In fact, the last and only work of Volta on animal electricity is a letter written 18 years before to Madame Le Noir, a "bluestocking" of Paris. Polvani states:

"We believe that the true, intimate motive which led Volta to present the new apparatus as suggested by the electric organ of the eel was the desire, if not the preoccupation, of demonstrating at once the identity of the electric fluid, created by the contacts between two different conductors, with the animal fluid which was then assumed and expounded by Galvani and by his followers. The great discussion between the two scientists, Galvani and Volta, lasted 10 years, but no letters were ever written between them."

Volta's own description of the battery, accompanied by his original drawings (Figure 1), is very clear and detailed. Here, again, no essential information has been omitted.

"I take a few dozens of small round plates or disks, of copper, brass, or better still of silver, about an inch in diameter, more or less (for instance, some coins). I get also an equal number of plates of tin or, which is much better, of zinc, of approximately the same shape and dimensions. I say approximately because it is not required at all that they be precisely the same, and in general the dimensions as well as the shape of the metal pieces are arbitrary. One should only take care to arrange them conveniently one on top of the other, in the form of a column. I also prepare a sufficiently large number of little disks of fiber board, of fur, or any other spongy material, capable of imbibing and retaining a large amount of water, or of the liquid with which they must be impregnated in order that the experiment be successful. These pieces or disks, which I will call wet disks, are made a little smaller than the metallic disks or plates, in order that when interleaved with them, as I will explain later, they will not reach beyond them.

"Having thus available all these pieces in good condition, that is the metal disks clean and dry, the nonmetallic disks well impregnated with water, or better still with salty water, and slightly dried, that the liquid will not drop off, there is nothing else to do but to arrange them conveniently. This arrangement is simple and easy. On top of a table or any other foundation I set horizontally one of the metal plates, for instance one of silver. On this first one I set a second plate of zinc, on this second one I lay one of the wet disks, then another plate of silver, directly followed by one of zinc, to which follows another wet disk. I continue in this manner, combining a silver disk with a zinc disk and always in the same direction, that is, silver below and zinc above, or vice versa, according to the way I started. I interpose between all these pairs a wet disk. I continue in this manner until a column is formed of these layers as high as it will hold itself up without collapsing."

Volta next describes now experiments which can be made with the battery, among which many are concerned with the effect of the electric current on the human senses, for instance the following:

"But the most curious among all these experiments is the following: Hold the metal blade lightly between your lips, and touch with it the point of the tongue. In fact, once the circuit is closed in a convenient manner, one will excite simultaneously, if the apparatus is sufficiently large and in good shape with sufficiently strong current, a sensation of light in the eyes, a convulsion on the lips and even in the tongue, a painful prick at the point of the tongue, finally followed by a sensation of taste."

In other letters Volta becomes a real artist in describing the beauty of the natural phenomena, as for instance the blue flame of the methane gas, which he discovered in the marshes of Lombardy.

"This gas burns very slowly with a lovely bluish flame—It is so pretty to see the opening of the jar cover itself with a little azure flame, which slowly descends along the sides of the jar."

There is also a magnificent description of the passage in the Alps at the St. Gothard Pass, where Volta relates how the grandiose and desolate scenery made him "see and feel the image of death."

Volta's letters reveal to us fully his genius, his mental processes, his discoveries. They also reveal to us his

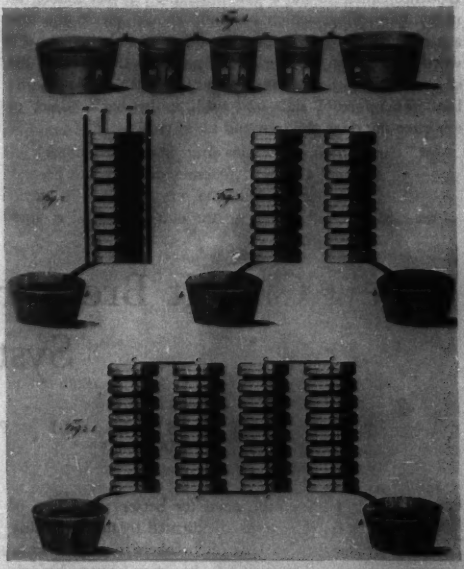

Figure 1. Volta's sketch of his first electric batteries, included in his letter of March 20, 1800, to Sir Joseph Banks

A denotes silver; Z denotes zinc

difficulties, as the lack of mercury needed to trap hydrogen and oxygen in sufficient quantity to produce water. However, Volta's letters disclose to us something more than the scientist, namely, the man in his entire personality. This human content of Volta's letters is perhaps even more fascinating than the purely scientific content.

Through his letters, we can follow Volta's early struggle for a life which would allow him to dedicate himself to science, when a well-meaning Jesuit priest tried to convince Volta to become a priest. Then we can follow Volta to Paris where the Emperor Napoleon and all of France received him in great glory and witnessed awe-struck his demonstration of the first electric battery. But what did the man Volta think of all these honors, of all this pomp? A single sentence from the letter to his wife from Paris reveals to us his feelings and his modesty. He did not seek honors but scientific truth, and the man's character appears clearer to us than we ever could hope otherwise. Volta writes on November 10, 1801, from Paris:

"Dearest wife . . . I will also tell you something of the success of my experiments and theories which have brought back to electricity the misunderstood galvanism. Everybody is convinced now, and all have adopted my ideas. But certainly I did not expect that something of the kind would create such a furor, nor that it would interest the highest personalities, so that the First Consul (Napoleon) conferred on me many awards. . . . As I finished to read my first paper, Bonaparte started to talk, exalted my discoveries, covered me with praise, and proposed that the Institute confer to me a gold medal. . . . Yet among so many happenings which certainly should please me and are even too flattering, I am not deceived to believe myself worth more than I am. And I prefer to the frenzied life of a vain glory the tranquility and pleasantness of domestic life. Therefore, I sigh and wish to be back home, to embrace my dear children and all of you . . ."

Volta lived in an epoch of fierce political passions. During his life Italy was torn asunder by the opposing French and Austro-Russian armies and by the two corresponding Italian political factions. Volta's great sense of balance made him shun the excesses of either party, as appears clearly from the letters written in that period. Naturally Volta's attitude pleased neither the French nor the Austro-Russians. All he wanted was to protect his freedom as a scientist, and in fact he was respected by both French and Austrians, and while the fight was raging "he was able to give the battery to mankind, a much greater gift than any political regime based on force and violence, of whatever color it may be."[3]

At the close of this review of Volta's letters, it is well to linger and perhaps regret a little that today's scientists do not write letters as Volta did. Technical papers receive much greater and quicker attention than a lonely letter. Yet, as is evident, a technical paper contains less, perhaps much less, than a letter. To be sure, it contains all technical and scientific information, often very well condensed and arranged, but the soul of the writer, alas, very seldom can pierce the printed sheet, and this, we think, may be a great loss in some cases. Perhaps this is the price we have to pay to an anonymous technology, to an ever-increasing specialization, to the many scientific magazines, where the information counts so much and the personality of the writer so little. If Volta had written only scientific papers his discoveries would have been recorded equally well, but through his letters something very precious remains forever: the sparkling personality of a great man and of a genius.

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New Circuit Breaker for Aircraft Electric Systems

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RECOGNITION of the need for better protection of aircraft electric systems is indicated by the increasing use of reverse-current circuit breakers in d-c generator circuits. Improved protection, however, must be extended to the entire electric system and not confined to the generating equipment. Protective equipment for low-capacity circuits in 28-volt d-c systems has been available. There has been a lack of protective equipment, however, for similar and higher capacity circuits in 120-volt systems, both alternating and direct current. A new circuit breaker with ratings up to 125 amperes, 120 volts alternating or direct current, is described in this article.

Briefly, the requirements for such a circuit breaker can be summarized by the following table.

Interrupting capacity	5,000 amperes sea level to 50,000 feet
Ultimate trip current	138 per cent of rated current at 25 degrees centigrade
Continuous current capacity	115 per cent of rated current at 25 degrees centigrade
200 per cent current calibration	10–100 seconds at 25 degrees centigrade
Ambient temperature range	−55 degrees centigrade to 71 degrees centigrade

A temperature-compensated thermal element maintains the calibration of this circuit breaker within relatively narrow limits over a wide range of ambient temperatures. With minor changes, this circuit breaker can be arranged for manual operation and for application in 28-volt systems.

Protective equipment for 120-volt aircraft electric systems has been lacking. Now a new circuit breaker with ratings from 40 to 125 amperes has been developed for a-c or d-c systems.

The circuit breaker, as shown in Figure 1, has an aluminum cover with mounting plates provided on one side. Power studs extend from an insulating base at one end of the circuit breaker. The control terminals of the closing and tripping solenoids extend through the cover at the opposite end. Exclusive of the power studs and mounting plates, the size is $7^{13}/_{32}$ by $5^{1}/_{4}$ by $1^{27}/_{32}$ inches. The weight of this remote operated circuit breaker is 4 pounds.

The circuit breaker with the cover removed is shown in Figure 2*A*. Separate side frames support the mechanism and the thermal trip unit. The general arrangement of the parts is illustrated in Figure 2*B*. At lower left is the thermal element assembly, and above and to the right are: *12*, the shunt trip; *2*, the closing solenoid; *3–8*, parts of the mechanism; and *9*, the interrupting chamber. The contacts are completely enclosed in this chamber and, therefore, are not visible in this illustration.

INTERRUPTER

THE PROBLEMS involved in developing an interrupter for 120-volt aircraft electric systems have been treated in an earlier article.[1] Briefly, if some means can be used to raise the pressure of the atmosphere immediately around the contacts, the arc can be interrupted quickly in an interrupter of reasonable size even at very high altitudes.

A cutaway view of the interrupter and contacts is shown in Figure 3. An enclosure is formed for the contacts and interrupter by the cap and base molded of arc-resistant phenolic asbestos compound. Silicone rubber gaskets (*7*) effectively seal the bottom of this enclosure. The moving contact consists of two parallel copper bridge members which are moved by the insulating operating rod (*1*). When closed, this contact completes the circuit between the stationary contacts; one on the bar attached to the thermal element, and the other on the connecting stud. Rapid opening to a total break distance of 3/4 of an inch is provided by the opening spring (*2*). The contact tip material, moving and stationary, is a form of silver tungsten-carbide which is characterized by arc resistance, freedom from welding, and fairly low contact resistance.

Closely surrounding the movable and stationary contact tips, and extending upward for slightly more than the length of the breaks, are tubes (*6*) of hard white vulcanized fiber. This material produces considerable gas when struck by an arc and does not deposit sufficient carbon to cause tracking. The blowout effect of the parallel arc streams causes the arcs, drawn between the contacts, to strike against the fiber at the higher current levels. At low current levels, the steel half-tubes (*8*) around the fiber tubes help deflect the arcs against the fiber. A valve (*4*), molded on the insulating contact operating rod, seats against a valve seat (*3*) in the cap when the contacts are in the open position. The gas produced by the arc striking the fiber is confined in the interrupter by this valve and the gaskets (*7*) between the base and the cap. The resulting increase in pressure quickly interrupts the arcs.

OPERATING MECHANISM

A FLOATING BEAM mechanism has been developed to operate the contacts of this circuit breaker in a straight line. This mechanism is shown in Figure 2*B*, with one of the supporting side frames removed. The contact operating rod is attached to the beam (*3*) at a point a little to the left of center. Under normal closing conditions, a latch (*10*) blocks one end of the beam while the other is moved downward by the plunger of the closing solenoid (*2*). The connection between the pushrod of the solenoid and the beam is made through springs (*6*) which provide the required contact pressure. A prop (*4*) and catch (*7*) hold the mechanism closed until such time as the latch (*10*) is released by the trip element, which allows the opening spring (*8*) to open the contacts quickly. In effect, the beam is latched at one end in closing, and is released at

Figure 1. Aircraft circuit breaker, single-pole, electrically operated, 120-volt 400-cycle, or direct current. Side oblique view, cover on

Full text of paper 52-131, "A New Circuit Breaker for Aircraft Electric System, 40 to 125 Amperes, 120 Volts, Alternating or Direct Current," recommended by the AIEE Committee on Air Transportation and approved by the AIEE Technical Program Committee for presentation at the AIEE South West District Meeting, St. Louis, Mo., April 15–17, 1952. Scheduled for publication in AIEE *Transactions*, volume 71, 1951.

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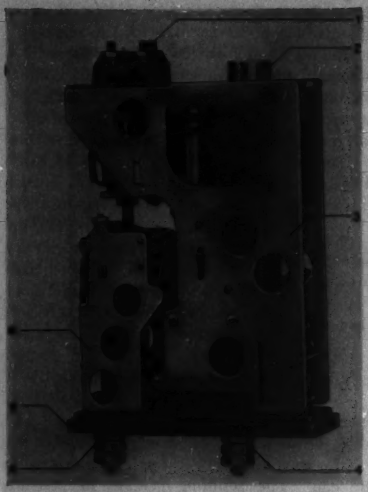
The authors acknowledge the assistance of Ruth E. Kern and other associates in the General Electric Company in the development of the circuit breaker and the preparation of this article. Acknowledgment is made also to the staff of the Equipment Laboratory of the Air Materiel Command for its assistance during the development of this circuit breaker.



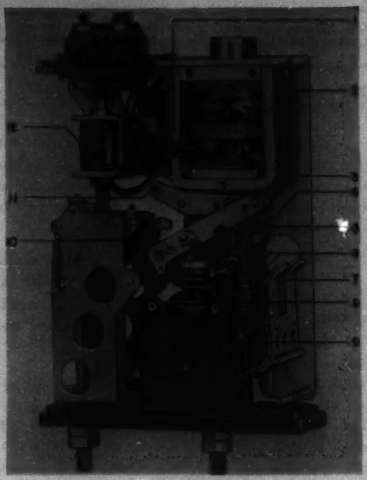


Figure 2. Aircraft circuit breaker, single pole, electrically operated.

A—Side oblique view with cover removed

1. Terminal board. 2. Closing solenoid. 3. Mechanism side frame. 4. Power studs. 5. Compound base. 6. Thermal element frame

B—Side oblique view with cover and mechanism side frame removed

1. Auxiliary switches. 2. Closing solenoid. 3. Mechanism beam. 4. Prop. 5. Solenoid push rod. 6. Contact pressure springs. 7. Catch. 8. Opening spring. 9. Interrupting chamber. 10. Latch. 11. Auxiliary switch actuator. 12. Shunt trip

the opposite end when the circuit breaker is tripped.

Although this mechanism is quite simple, it is trip-free. This means that the contacts are able to open fully and quickly if the circuit breaker is tripped while the mechanism is held in the closed position. With this type of mechanism the flow of power cannot be maintained through the circuit breaker into a fault.

CLOSING SOLENOID

TO MAINTAIN the size and weight of the closing solenoid at a minimum, it has been designed with an operating winding of very short time rating. A second, higher resistance, winding is introduced into the circuit after the solenoid has closed the operating mechanism. The two windings in series may be continuously energized without overheating.

The circuit of the solenoid and short-circuiting switch is shown schematically in Figure 6. When the solenoid plunger comes to the end of its stroke, the short-circuiting switch (*1*) in Figure 2*B*, is opened and both windings are placed in series. As long as the solenoid is energized, sufficient force is produced to hold the plunger in the closed position regardless of whether the mechanism remains closed or not. Only upon opening and reclosing the control switch will the solenoid attempt to reclose the mechanism.

This type of control scheme is often referred to as an antipump, signifying that the closing solenoid, when energized, makes but one attempt to close the circuit breaker.

TRIP DEVICES

OVERLOAD TRIPPING is accomplished in this circuit breaker by means of a temperature-compensated linear expansion thermal element, shown in Figure 4.

The element proper (*5*) is made of material with a resistivity dependent upon the current rating of the circuit breaker. Current passing directly through the element provides the heat to raise its temperature to the tripping point. The small motion of the top of the element due to its linear expansion, is amplified approximately 20 times by an eccentric (*3*) and trip arm (*10*). This amplified motion is applied to the instantaneous trip armature (*7*), which, when rotated sufficiently, releases the latch. The force which the trip arm exerts is supplied by two tension springs. Compensation for changes in ambient temperature is provided by the expansion of the trip unit side frames; the temperature coefficient of expansion of

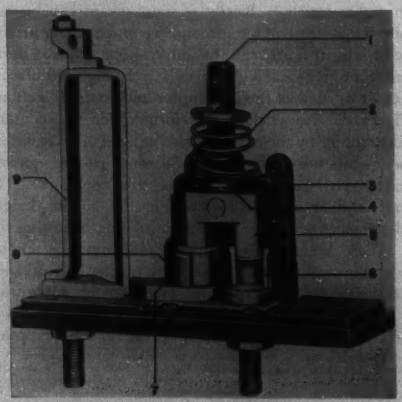


Figure 3. Cutaway view of interrupting chamber

1. Contact operating rod. 2. Opening spring. 3. Valve seat. 4. Valve. 5. Bridge contacts. 6. Fiber tubes. 7. Gaskets. 8. Steel half-tubes. 9. Expansion thermal element

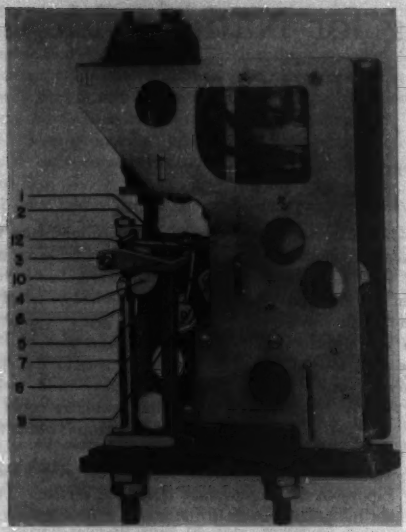
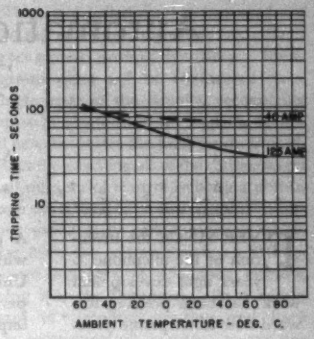


Figure 4. Thermal and instantaneous trip devices

1. Instantaneous trip armature. 2. Calibrating screw. 3. Eccentric 4. Instantaneous trip magnet. 5. Expansion element. 6. Operating spring. 7. Side frame. 8. Latch. 9. Mechanism beam. 10. Trip arm. 11. Armature return spring. 12. Calibrating screw. 13. Compound base

Figure 5. Typical time-ambient temperature tripping characteristic at 200 per cent current



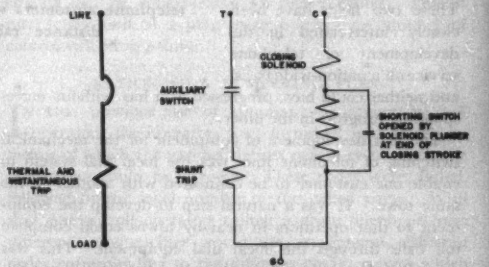


Figure 6. Circuit diagram for electrically operated aircraft circuit breaker

these frames being similar to that of the thermal element. Changes in ambient temperatures produce approximately the same linear change in both the side frames and the thermal element. Since the trip arm is pivoted in the side frames, the resultant motion, at the end of the trip arm, is negligible.

Sufficient air space between the element and the side frames prevents the heat transfer between them during overload from not adversely affecting the tripping characteristics.

Combined with the thermal trip is a magnetic trip consisting of armature (*1*) and magnet (*4*). The instantaneous tripping, obtained at currents above seven to ten times the rated current, provides better protection for cables and loads, and reduces the circuit breaker burden.

The shunt trip device (*12*) in Figure 2*B* makes possible remote tripping over a wide range of system voltages. To protect the coil against overheating, one of the auxiliary switches (*1*) in Figure 2*B* is connected in series with the shunt trip coil, as shown in Figure 6. As the circuit breaker trips, this switch automatically opens and de-energizes the coil.

At 25 degrees centigrade the tripping characteristics of this circuit breaker are as follows:

Per Cent Current	Tripping Time
115	In excess of 1 hour
138	Less than 1 hour
200	10 to 100 seconds for all ratings

The effect of ambient temperature is small at the ultimate trip current. Over the range of temperatures from −55 to +71 degrees centigrade, the ultimate trip current is between 115 and 150 per cent.

The tripping time at 200 per cent current is affected by ambient temperature as shown by the typical curves for the 40- and 125-ampere ratings in Figure 5. Over a range of ambient temperatures from −55 to +71 degrees centigrade, the tripping time is 10 to 200 seconds for all ratings from 40 to 125 amperes.

CONCLUSIONS

THIS NEWLY developed aircraft circuit breaker meets the general requirements for aircraft electric equipment, and the specific requirements given previously.

The temperature-compensated overload thermal trip provides improved protection for cables and loads over a wide range of ambient temperatures. Remote operation makes possible the protection of remote loads or load busses with a minimum expenditure of weight.

The tripping characteristics are such that this circuit breaker may be used in either d-c or a-c systems. Adequate interrupting capacity, 5,000 amperes, is provided for all feeder and distribution circuit applications.

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Automatic Switching for Nation-wide Telephone Service

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A plan for automatic long-distance switching, which ultimately will embrace the whole of the United States and extend into Canada and perhaps Mexico, has been formulated and important steps have been taken toward its realization. The plan also contemplates that telephone customers will be able to dial long-distance calls themselves.

EVER SINCE the invention of the telephone 76 years ago, development work has been pressing forward both in telephone transmission and in switching. These two fields have been closely interrelated in the development of telephone service on a nation-wide basis, and neither could have progressed as it has without corresponding progress in the other.

The first development of equipment for the mechanical switching of telephone lines was the local dial system to enable one customer to be connected with another in the same town. It was a natural step to develop the equipment so that operators in near-by towns could complete toll calls through this local dial equipment. This was done first by using the local equipment and then with progressive modifications making it more and more suitable for toll.

By these means through the decades of the 1920's and 1930's regional networks were developed for operator toll dialing, using step-by-step types of equipment, particularly in Southern California, Connecticut, and Ohio. Also, many short-haul toll calls in metropolitan areas were handled in connection with the panel-type dial equipment which was developed for automatic switching in these areas.

Also during this period the range of customer dialing in large metropolitan areas was extended, where local service is measured by message registers, through arrangements for the multiple registration of calls for which the charge was more than one local unit.

An important feature of switching development in this period was the perfecting of "common control" switching systems for large metropolitan areas endowed with a high degree of intelligence and great reliability.[1] As will be shown, still more extensive and complicated functions must be performed by the common control systems of a nation-wide automatic switching system.

Also throughout this period great advance was made in the quality and stability of long-distance circuits. Telephone connections, some with as many as five circuits in tandem, were being regularly established by telephone operators with satisfactory over-all transmission. The limitation was in the speed and accuracy with which multiple switches could be made by operators rather than in the over-all transmission characteristics.

Several factors have worked together to bring about a big expansion of long-distance telephone service. These include the great growth in the numbers of telephones in service, improvements in long-distance transmission, in switching, and in methods of traffic operation. Since automatic switching becomes increasingly attractive as the traffic density increases, this large growth pointed toward the desirability of further mechanizing the switching operations.

In 1943 there was cut into service in Philadelphia, Pa., the first installation of the Number 4 toll crossbar system.[2] This system was designed to enable general automatic switching of toll connections in and out of large metropolitan areas and had many of the capabilities necessary for nation-wide switching.

The various considerations already mentioned, coupled with the success of the Number 4 installation at Philadelphia, led to studies of the service and operating results which might be expected from a nation-wide extension of automatic switching. The conclusion was reached that this would be a desirable objective of the Bell System companies and would result in a very substantial further improvement in the speed and accuracy of handling of long-distance messages. Accordingly, during the next few years, a national plan was prepared and was adopted by the telephone companies.

GENERAL PLAN

THE FEATURES of this nation-wide plan for automatic switching and the present status of its application are the subject of three technical papers[3–5] which will be published in subsequent issues of *Electrical Engineering*. The basic requirements to be met in the development of this plan included the following:

1. It should be suitable for the nation-wide extension of automatic switching both by originating toll operators and by the customers direct.

When this work was commenced it was clear that a

Full text of paper 52-201, "Automatic Switching for Nation-wide Telephone Service," recommended by the AIEE Committee on Communication Switching Systems and approved by the AIEE Technical Program Committee for presentation at the AIEE Summer General Meeting, Minneapolis, Minn., June 23–27, 1952. Scheduled for publication in the AIEE *Transactions*, volume 71, 1952.

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This is the first of a series of four articles.

program leading toward general nation-wide operator dialing was desirable. Subsequent developments have confirmed the wisdom of making the basic plan consistent with general nation-wide customer dialing as well since it now appears that a very wide extension of this form of service will become desirable.

2. The plan must provide for satisfactory over-all service between any two telephones in this country and Canada.

Under manual operation, satisfactory over-all service was provided for by the general toll switching plan in use since about 1930. This plan is modified to recognize the far greater speed and accuracy of automatic switching compared with manual switching. This also involves modifications of transmission design standards so that the over-all connections will continue to be satisfactory.

3. The system must be designed for instantaneous service, so that delays due to lack of circuits or equipment would be very infrequent. This is necessary, both from the standpoints of service and the avoidance of tieups, particularly of the automatic switching machinery.

A trunking system therefore must be devised which will meet this requirement most economically, considering over-all costs of lines, switching equipment, and operation.

4. Machines must be designed for use at strategic points in the network, called control switching points, to perform automatically the various tasks required to make the over-all plan operative and economical.

5. The entire plan must be such as to provide satisfactorily for growth, for flexibility to meet changing conditions, and for minimum over-all costs of operation.

FUNDAMENTAL PLANS FOR TOLL PLANT

In the next article of this series, J. J. Pilliod discusses the fundamental layout of plant for nation-wide operator toll dialing. This is subject to changes from time to time with further specific studies, as is the case with all far-reaching fundamental plans of this type. The additional requirements imposed by nation-wide customer dialing are still under study as will be discussed a little later.

The national toll switching plan is modified so that there may be a maximum of eight toll circuits switched together to connect any two telephones compared with the previous limit of five.[6] In order to handle the entire traffic of the country, approximately 100 control switching points are necessary at which highly intelligent common control switching systems of the Number 4 crossbar type will be placed.

A very important feature of the layout is a trunking plan providing for a high degree of use of alternative routes. To design all of the toll circuit groups of the country for a no-delay service would be very expensive. However, taking advantage of the extreme rapidity of automatic switching and the ability to build into the machine capacity for using a large number of alternative routes, a trunking system has been devised in which only about one-sixth of the toll circuit groups of the country need be engineered on a very liberal basis. These are called final groups and are the groups to which the machine ultimately appeals if all of the more direct circuit groups are busy. These more direct circuit groups then can be engineered on a basis providing for high usage of the circuits, recognizing that when one group is busy the machine appeals to another and so on until as a last resort the final group is used.

In determining means for handling all of the toll messages with a relatively small number of control switching points, tremendous advantage was derived from modern transmission developments, particularly carrier systems which give a great economy from the concentration on a long-distance route of large numbers of telephone circuits, numbers often running into the thousands. As a result, a considerable degree of circuitous routing and back hauling of circuits is economical if by these means the circuits can be concentrated on heavy routes. This in turn lends itself to a plan using a minimum number of control switching points.

NATION-WIDE NUMBERING PLAN

In the previous use of automatic switching by toll operators, the operators were furnished with codes by means of which the various circuits necessary to reach the destination could be selected. These codes were dialed, followed by the local number of the called party. With that system, toll operators calling a given telephone from different remote cities would use, in general, different codes corresponding to the different circuit groups which they must select.

For nation-wide toll dialing even by operators this system would have impossible complications, and for nation-wide customer dialing it is clear that the code to be dialed must uniquely represent the office which serves the called telephone and that office only and not be dependent upon the route to be followed to reach it. In other words, it involves the development of what is called a destination-type code. Another description of this code plan is to say that for toll dialing purposes each telephone in the country (and Canada) must have a distinctive telephone number different from that of every other telephone. It is also clear that as a practical matter this number should be based upon the local telephone number of the customer prefixed by a minimum number of digits, following easily understood rules.

To bring this about has involved a very high order of planning. Such a plan has been perfected and currently forms the basis for the determination of the coding of all new telephone offices and for changes in office codes when these are necessary. The development of this is the subject of a subsequent article.

CUSTOMER TOLL DIALING

When the customer is to dial long-distance calls directly without assistance from any operator, two additional requirements are imposed beyond those necessary for nation-wide operator dialing.

1. The customer normally is connected to a local central office, but for the purpose of nation-wide toll dialing

he must be connected to the nation-wide toll network. At present he does this by dialing a code such as "211" which connects him with the long-distance operator. This procedure could be continued. However, since the customer, in any event, must dial 10 digits for the longest hauls to designate the called telephone, it is desirable if possible to cut out this preliminary step. That would mean modifying the local central office equipment so that it would receive the 10-digit numbers and transmit them on to the toll equipment. This is a simple undertaking for local central offices using the latest type of local central office equipment, called Number 5 crossbar, which was designed with this in view.[7] For older types of equipment, the job is more difficult.

2. The switching equipment must be provided with automatic means for recording all of the information necessary for charging the call. In the case of operator dialing this is now done manually by the operator.

Great advances have been made in recent years in the development of automatic message-recording equipment. In 1944 there was placed in service in California the first installation in this country of automatic ticketing equipment.[8] This equipment is associated with step-by-step local switching equipment and automatically prints for each call a ticket similar to that prepared by the operator with manual operation. In 1948 there was installed in Media, near Philadelphia, a greatly improved type of message-recording equipment in which the information appears in the form of punched holes in a tape.[9] This equipment is much more economical than the earlier system and also lends itself to the automatic preparation of toll statements or bills.

The present forms of equipment have been designed to be associated with local central offices. A careful study has been made of their field of application and of the basic plan necessary to provide for a general nation-wide extension of customer dialing. This indicates that there will be a large field for automatic message accounting equipment associated with the toll network and arranged to receive orders for toll messages from a number of local dial offices. This centralized automatic message accounting equipment is under development and an initial installation will be made next year in Washington, D. C. In this installation the range of customer dialing will be limited and certain service features will be lacking, which it is planned to add later.

The nation-wide extension of customer toll dialing involves many operating problems in addition to those relating to the design of the plant. These problems involve the extent to which customers wish to dial long-distance calls, requiring ten pulls of the dial, the accuracy of dialing, the treatment of wrong numbers, provision for giving subscribers information regarding telephone numbers in distant cities, information on charges, and many other questions.

Recognizing that the best way to develop these questions is a trial, arrangements were made to open such a trial last fall at Englewood, N. J. This office is equipped with a Number 5 crossbar system so that arrangements for such a trial readily could be made there. The Englewood customers are able to dial directly any of about 11,000,000 telephones in ten metropolitan areas scattered throughout the country, including Boston, New York, Pittsburgh, Cleveland, Chicago, San Francisco, and the Bay area.

The results of this trial have been very encouraging. Subscribers are continuing to dial over 95 per cent of all the calls which can be dialed. Errors due to wrong numbers are at a minimum and other difficulties are relatively low. In so far as this trial can answer the questions, the results are all in favor of the nation-wide extension of customer dialing as the development and installation of facilities suitable for this purpose make it possible to do so.

In view of the prospect of nation-wide customer dialing, fundamental plan studies are now being made by the telephone companies throughout the country of the whole layout of plant including the distribution of centralized automatic message accounting equipments with the future general application of this method of operation. The present indication is that the number of points at which toll operating centers will be required will be greatly reduced. This will react in important ways on the design of telephone buildings, telephone equipment installations, and toll circuit routes.

All of these plans depend upon the successful development of striking innovations in toll switching and automatic message accounting equipments. The plans in turn react upon the features to be incorporated in such equipments and upon the schedule of their development. A subsequent article covers the more important features of these equipments and problems involved in their development.

CONCLUSIONS

Experience with operator toll dialing shows clearly that it provides a marked improvement in toll service. This improvement will increase as progress is made toward the full application of the nation-wide automatic switching plan.

The development of long-distance dialing by customers is at an early stage. The results of recent trials, however, indicate that nation-wide customer dialing has service advantages and will be received generally with enthusiasm by telephone users. It is anticipated, therefore, that customer dialing will expand rapidly both on a regional and on a nation-wide basis.

The service advantages of nation-wide automatic switching are not measured entirely by the increased speed and improved accuracy of connections. An important factor is the continued ability of the telephone system to meet the rapidly increasing demand for telephone service without making excessive demands on the available supply of labor. The development of local dial operation was absolutely necessary to handle the great growth of local telephoning which has taken place. Today, in many places, requirements for people for toll operations are very heavy and an increased amount of automatic toll switching is becoming more and more necessary to make possible handling the rapidly increasing number of long-distance telephone messages.

With this development there has been a marked increase of employment. The Bell Companies today employ 244,000 operators compared with 131,000 in 1941. They also have employed many people to build and install about $300,000,000 worth of toll dialing equipment, to construct places to house it, maintain it, and carry out operating rearrangements.

With respect to the future, even with the nation-wide automatic switching plan in full operation and the local central offices arranged to permit customer dialing, there still will be a large amount of work for operators. They will be required to handle information and assistance traffic, person-to-person calls, collect calls, and other classes of calls which do not lend themselves to customer handling, as well as any individual calls which the customers may not wish to dial themselves.

The Bell Companies necessarily have taken the lead in planning and applying these new developments. The plans, however, are laid in such a way as to include telephone users in independent telephone company offices. The independent companies are being kept fully informed of these plans as they develop and are participating, as the development of their own plant makes it practicable and desirable, in extending the benefits of the new forms of operation to their own customers.

This long-term development has required the very close co-operation of all parts of the Bell System: American Telephone and Telegraph Company General Department, Bell Telephone Laboratories, Western Electric Company, Long Lines, and all of the Bell Operating Companies. Each installation of equipment and circuits and each operation is a part of a nation-wide system and must be closely co-ordinated. The close interrelation and working together of the various parts of the Bell Telephone System, research and development, manufacturing, engineering, and operating are necessary for the effective planning and execution of this tremendous project.

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Transformer Noise Study Simplified With Tape Recorder

Research engineers of the General Electric Company have found a simple way to bring the hum of operating transformers into the laboratory for study with the use of the familiar tape recording machine. Before this comparatively easy method was discovered, data on transformer noise in the field were gathered by taking heavy and cumbersome instruments to transformer locations. Measurements obtained at the site were not always accurate because of the rough treatment and rapid temperature changes to which the instruments were subjected. Now the formerly used sound analyzer and high-speed recorder are left at the laboratory, and a high-fidelity magnetic-tape recorder is substituted to gather research information.

In the new method, the output of a sound level meter is fed into a tape recorder and a 2-minute recording is made at various microphone locations. Appropriate technical information is recorded verbally with each recording. A standard sound also is picked up by microphone and recorded at intervals of about 15 minutes for calibration purposes. The result is a permanent record of transformer noise and other pertinent field data which may be analyzed under ideal laboratory conditions.

Engineers say the use of the tape recorder has the additional advantage of permitting subjective judgments of the less tangible aspects of apparatus noise.

General Electric engineers use a magnetic tape recorder to gather sound data on transformer noise. Later, in the laboratory, the tape recording will be played back for sound level determinations and frequency analyses

A High-Speed Direct-Scanning Facsimile System

C. R. DEIBERT F. T. TURNER R. H. SNIDER

THE WESTERN UNION high-speed facsimile terminal transmits and receives copy up to $8^1/_2$ by 15 inches at the rate of $2^1/_2$ square inches per second. Assuming normal margins at top and bottom of page, $8^1/_2$- by 11-inch letters may be sent at the rate of 80 per hour, including phasing time between messages.

Definition is adequate for reproduction of 8-point type. Assuming full copy sheets, a speed of up to 3,000 words per minute is available, depending on type size. For elite type 1,500 words per minute is achieved. Photographs, half tones, and line drawings also may be transmitted.

No advance preparation or processing of copy is required, direct scanning being employed at the transmitter. Copy is received on a page-type continuous recorder, on "Teledeltos" electrical recording paper. Received copy requires no drying, pressing, or other processing, and is fadeproof. Messages are automatically cut off and ejected from the recorder within one second after the end of each transmission.

A bandwidth of 30 kc is required, assuming double-sideband transmission.

The transmitter comprises two identical units each consisting of a transparent plastic cylinder which rotates at 1,800 rpm during transmission. The copy is inserted face out in the cylinder and is held in the focal plane by centrifugal force. Scanning is accomplished therefore by the conventional facsimile scanning optical system.

The two units operate alternately to conserve line time, one unit transmitting while copy is changed in the other. Operation is almost completely automatic. Opening and closing of access doors in the cylinder ends initiates transmission, and adjustable top and bottom margin stops may be set to avoid transmission of blank portions of the page.

Controls are provided at the transmitter to adjust the contrast range or background level to accommodate a wide range of copy quality.

Since the apparatus operates at a speed intermediate between that of conventional facsimile apparatus, 60 to 360 rpm, and that of systems operating at speeds comparable to those used in television, control apparatus and circuits logically use techniques from both of the aforementioned extremes. Starting, line feed, stopping, and so forth, use relays, motors, and mechanical brakes, while phasing and blanking pulses are generated electronically from a signal derived from the gap between the edges of the paper by an auxiliary stationary scanner.

Electronic means including clippers, differentiating circuits, multivibrators, and modulators are employed to clip, shape, and establish the duration of phasing pulses, and to develop blanking pulses to delete the "black" signal generated by the facsimile scanner from the gap between the paper edges

Tuning-fork frequency standards at each end of the circuit maintain synchronism, and servomechanisms are employed to stabilize the rotating elements.

The recorder consists of motors and feed rollers to carry a continuous strip of recording paper from a 600-foot roll, a continuous belt on which are mounted 4 styli, the tips of which sequentially contact the surface of the paper, and fast-feed and knife mechanisms which feed out, cut off, and eject the copy.

Phasing is accomplished at the recorder in a minimum time consistent with accuracy by advancing the phase of the alternating voltage driving the stylus motor until coincidence is obtained between the transmitted phasing pulse and a pulse generated by the recorder.

Figure 1. A complete high-speed facsimile terminal

Digest of paper 52-105, "A High-Speed Direct-Scanning Facsimile System," recommended by the AIEE Committee on Telegraph Systems and approved by the AIEE Technical Program Committee for presentation at the AIEE Winter General Meeting, New York, N. Y., January 21-25, 1952. Scheduled for publication in AIEE *Transactions*, volume 71, 1952.

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Fundamental Plans for Toll Telephone Plant

J. J. PILLIOD
FELLOW AIEE

The introduction of mechanical operation and general improvement in the transmission performance of the communication plant over the years permits the fundamental plans under which toll facilities are provided to be revised rather radically. The important new features and service improvements of the current plans are outlined herein.

THE GENERALLY excellent long-distanec telephone service enjoyed by the public in the United States and Canada is the result of the co-operative work of many organizations including the Bell Operating Companies, many independent connecting companies and others in the United States as well as in adjoining countries. The techniques employed today reflect extensive research and engineering and also improvements in manufacturing skill and in construction, maintenance, and operating methods developed over a period of many years.

Throughout the United States and Canada there are approximately 20,000 different places—cities, towns, and villages—that serve as toll connecting points. The telephone offices in each of these places have access through the toll network to practically all of the 50,000,000 telephones in the United States and Canada and also to most of the telephones in the rest of the world. Currently the Bell Operating Companies are handling toll calls at an average rate of over 7,000,000 during a business day.

Whenever practicable and economical, direct circuits are used to handle toll message traffic between two given points. Much of the traffic in the country is handled this way. However, a substantial volume of business, about 20 per cent, is handled as a matter of economy, by switching toll circuits together. Although the volume of traffic between different points may vary over a wide range, it is nevertheless important that adequate service be provided between any two points regardless of their separation and regardless of whether the traffic volume be a few calls per year or many calls per hour. This requires a definite and comprehensive switching plan.

ELEMENTS OF THE PROBLEM

FIGURE 1 shows the nearly 1,200 points in Wisconsin and Minnesota at which exchange facilities may be connected to the toll network. The coverage indicated is typical of that found throughout the country.

The 150-odd larger circles represent "toll centers." At these places, operators record toll calls and perform other toll-operating functions. Switching arrangements of various types are provided depending on how the point fits into the switching plan. Some may operate as control switching points in the nation-wide plan as described later. The smaller circles represent "tributaries." These are places where little or no toll operating is done. Toll connections from these points to the nation-wide toll network are completed at the toll centers.

In the United States and Canada as a whole, there are approximately 2,600 toll centers. The remainder of the toll connecting points—about 17,500—are tributaries.

Figure 2 shows the network of circuit groups required to interconnect the toll centers in one area. Each line represents a group of "intertoll trunks," connecting two toll centers. These groups contain varying numbers of trunks. The location of the lines on the map is unrelated to the geographical routing of the trunks. To simplify the chart, the clusters of relatively short circuit groups radiating from each toll center to its tributaries have been omitted.

Physically, the plant consists of a network of open-wire lines, cables, and radio systems. Voice-frequency or carrier operation is employed in the various sections as required to provide the necessary intertoll trunks. Figure 3 shows the major Bell System toll routes. In addition to the long haul

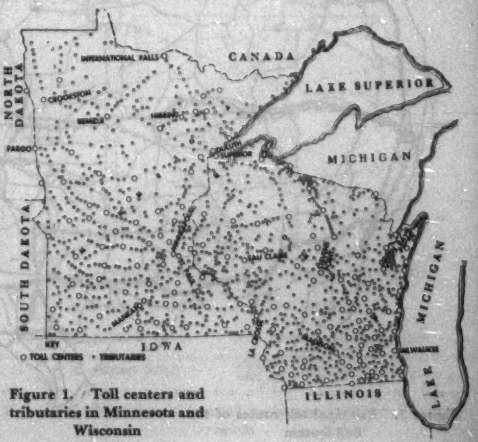

Figure 1. Toll centers and tributaries in Minnesota and Wisconsin

Revised text of paper 52-202, "Fundamental Plans for Toll Telephone Plant," recommended by the AIEE Committee on Communication Switching Systems and approved by the AIEE Technical Program Committee for presentation at the AIEE Summer General Meeting, Minneapolis, Minn., June 23–27, 1952. Scheduled for publication in AIEE *Transactions*, volume 71, 1952.

J. J. Pilliod is assistant chief engineer of the American Telephone and Telegraph Company, New York, N. Y. This is the second in a series of four articles; the first was "Automatic Switching for Nation-wide Telephone Service," A. B. Clark, H. S. Osborne, see pages 780–783, this issue.

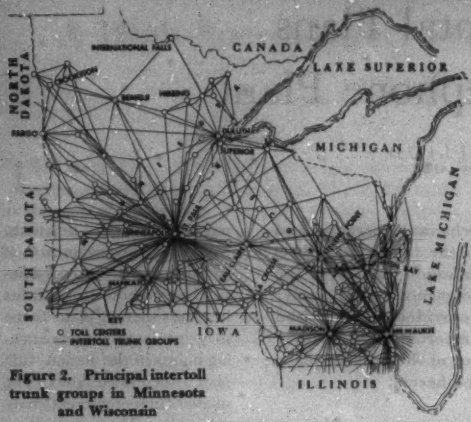

Figure 2. Principal intertoll trunk groups in Minnesota and Wisconsin

routes shown, there are many other shorter haul routes connecting the toll service points within local areas which are not shown.

EARLIER TOLL SWITCHING PLANS

VERY EARLY it became evident that: 1. There must be a plan for connecting circuits together. 2. Switching centers with suitable equipment must be established in accordance with this plan. 3. Trunks must be provided in adequate numbers to connect every place to one or more switching centers and to interconnect the switching centers. 4. All this must be done in such a way that good service will be provided at reasonable cost.

Early plans crystallized into the General Toll Switching Plan introduced by the Bell System Companies more than 20 years ago.[1] This comprehensive plan for handling telephone toll traffic in the United States and Eastern Canada involved the use of two classes of major switching centers, Regional Centers and Primary Outlets, and established methods of designing toll trunks to give adequate transmission efficiency on all necessary toll connections.

SWITCHING PLAN FOR NATION-WIDE TOLL DIALING

THIS GENERAL TOLL switching plan was based on manual switching, that is, switching by operators, and a toll plant made up for the most part of voice-frequency circuits. Under it, connections were limited to five intertoll trunks in tandem. This was fixed because the chance that difficulties due to operating irregularities, delays, or transmission impairments will be experienced, tends to increase with the number of manual switches and voice-frequency trunks in tandem.

The introduction of mechanical switching, which is fast and designed to be practically free of operating irregularities, permits delays to be minimized by fast switching to alternate routes. The use of carrier, which has grown from a relatively minor place in the toll plant to the point where it is now commonplace,[2] provides superior transmission performance.

The number of toll connections requiring a single toll operator only or, in some cases where customer dialing is used, no operator at all is increasing steadily as additional local and toll switching systems are mechanized.[3,4]

Since 1930, growth in traffic has been tremendous. Toll messages in the Bell Operating Companies in the United States and Canada have more than trebled, growing from an annual volume of about 650 million to about 2 billion. This continuing growth in traffic volume has required a large-scale development of new plant facilities.

Consideration of these factors led to the gradual reorientation of the fundamental plans for the intertoll trunk plant which is now underway.

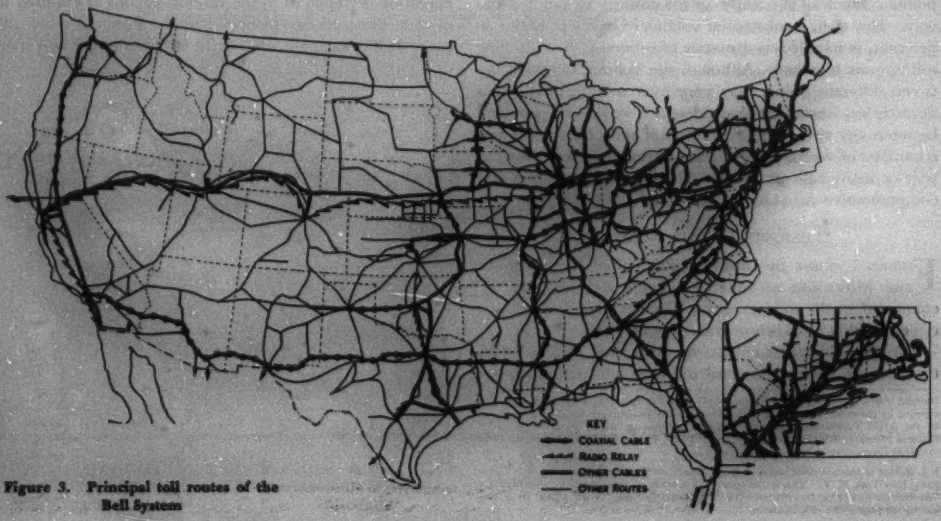

Figure 3. Principal toll routes of the Bell System

The proposed general toll switching plan provides a systematic grouping of switching points. These include ordinary Toll Centers (TC), each serving a cluster of nearby tributary points and having trunks to a "home" Primary Outlet (PO) which serves as the outlet for several surrounding toll centers. In some cases, simplified switching equipment may be used at a PO location. Such centers are called Tandem Outlets (TO). Each PO or TO has trunks to a "home" Sectional Center (SC) which serves as an outlet for the PO's or TO's in a "Section." The various SC's have trunks to a Regional Center (RC) which serves as the central switching point for the sectional centers within a "Region." There are nine regions in the United States and Canada. One of the RC's (St. Louis) is termed the National Center (NC). The higher order switching centers also act in the capacity of the lower order centers. For example, each SC also acts as the PO and TC for its local area.

This arrangement is illustrated in Figure 4. Hibbing, Minn., is shown as a representative toll center with the tributaries it serves. It is in the service area of the Duluth TO, the approximate boundaries of which are indicated. Duluth lies in the Minneapolis "Section," which includes a large portion of Minnesota, and is in turn one segment of the Chicago "Region."

Toll calls between two tributaries in the Hibbing toll center area can be completed by switching at Hibbing. Toll calls between any two points within the Duluth TO area can be completed by switching at Duluth. In a similar manner, connections between any two points in the same sectional center area or in the same regional center area may be handled by switching at the SC or RC, as the case may be. For example, a connection from Hibbing to a toll center anywhere in the Chicago region (which involves more than six states as shown in Figure 6) can be established by connecting toll links between Hibbing and Duluth, Duluth and Minneapolis, and Minneapolis and Chicago, to a corresponding number of links on through another sectional center, and primary or tandem outlet to the toll center destination. Circuits between a toll center and its tributaries are not referred to as intertoll trunks but are classed as toll connecting trunks.

Where the volume of traffic warrants, direct circuits may be provided to by-pass the intermediate switching points included in the preceding example. Once such direct circuit groups have been established, advantage is taken of their existence to avoid switches. The routes provided under the basic plan then constitute "final" routes to be used only when the more direct circuit combinations are busy.

The direct circuits are engineered on a "high-usage" basis to carry high loads per circuit with a minimum of idle circuit time. The "final" groups are liberally engineered to take care of not only their own loads as direct circuits but also the overflow from the high-usage groups during heavy traffic periods. The high-usage and final groups which could be used for routing calls between Hibbing, Minn., and Davenport, Iowa, are shown by Figure 4.

Figure 5 is a generalized diagram of a typical arrangement of switching points and intertoll trunks in two regions.

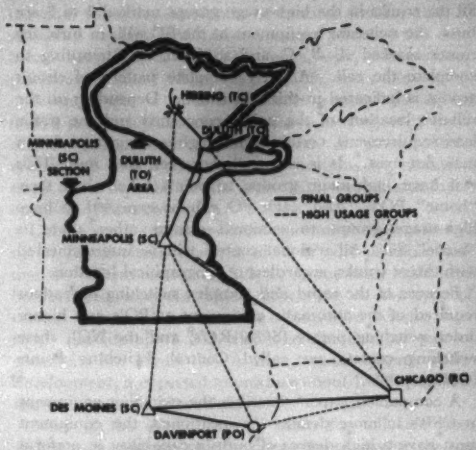

Figure 4. Intertoll trunks between Davenport, Iowa, and Hibbing, Minn., showing alternate routing possibilities

It is apparent that while the mechanical switching system need perform only relatively simple toll switching operations at the toll centers, it must be capable at the higher order switching points of selecting the most favorable route available at the time and completing the connection to the next switching point.

For example, on a call from a given primary outlet such as PO1 to a toll center in the other region such as TC2, the switching equipment at PO1 attempts to complete the connection in sequence over the routes marked 1 to 6. If route 6, which is the "final" route, is selected because

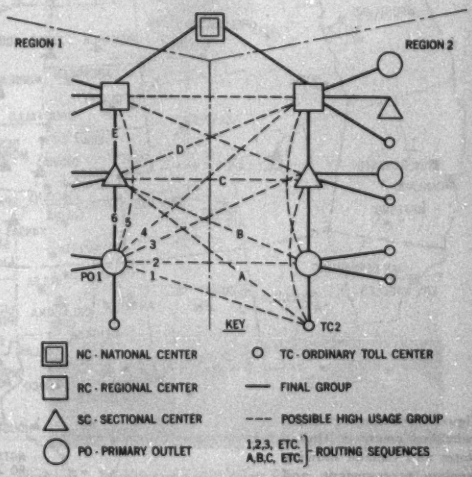

Figure 5. Illustration of intertoll routing pattern between two regions

all the trunks in the high-usage groups marked 1 to 5 are busy, the switching equipment at the SC will, in turn, try routes marked *A*, *B*, *C*, and so forth, in attempting to complete the call. A fairly complete pattern of circuit groups is indicated in this illustration. Depending on the relative locations of the points concerned and the traffic load requirements, certain of the high-usage groups shown may not exist. It is expected, however, that most TC's will have high-usage groups to points other than their "home" PO's. Also, each PO can be expected to have high-usage groups to sectional centers other than its "home" SC. All regional centers will be interconnected with direct trunks, regardless of geographical location.

Because of the rapid and complex switching operations required of the automatic equipment at PO's and higher order switching points (SC's, RC's, and the NC), these switching centers are called Control Switching Points (CSP's).

A companion paper[4] describes the switching equipment at CSP's in more detail. As mentioned, this equipment must have a high degree of built-in capability to perform quickly the circuit selection work associated with the alternate routing features of the switching plan. In addition, to help provide the transmission margins needed for satisfactory operation of the plan as contemplated, it is arranged to connect circuits on a 4-wire basis instead of the 2-wire basis used generally heretofore at all switching points and at toll centers only under the new plan. Also it must perform the very important function of tying toll networks which serve limited local areas together so that collectively they will work as a smoothly functioning nation-wide system. This requires co-ordination between the design of the individual limited networks and the design of the over-all system.

The locations of the control switching points needed to implement the nation-wide switching plan as now proposed are shown in Figure 6. This figure also indicates the boundaries of the regional switching areas and the home switching center of the higher order for each switching point. As the number of CSP's increases, the cost of the toll circuit plant decreases, because each CSP then can be located closer to the cluster of ordinary toll centers which it serves. However, because of the cost of the CSP equipment, practical applications must balance the cost of circuit facilities against the cost of equipment in arriving at the minimum over-all cost for the switching plant.

Customer dialing of short-haul toll calls has been in use, particularly in metropolitan areas, for some years. A trial of long-haul customer dialing over the intertoll trunk network and through the switching equipment provided for operator toll dialing was instituted at Englewood, N. J., in the fall of 1951. The local equipment includes automatic message accounting and permits Englewood customers to dial directly to about 11,000,000 telephones in ten metropolitan areas across the country. A trial installation of customer toll dialing, utilizing automatic-message-accounting equipment on a centralized basis rather than at each local office, is planned for Washington, D. C., in the fall of 1953. Initially, customers will dial toll calls within the Washington metropolitan area and to such points as Baltimore and Annapolis, Md. The favorable results and general acceptance of the trial at Englewood indicate extensive application of customer dialing of toll calls as conditions warrant.

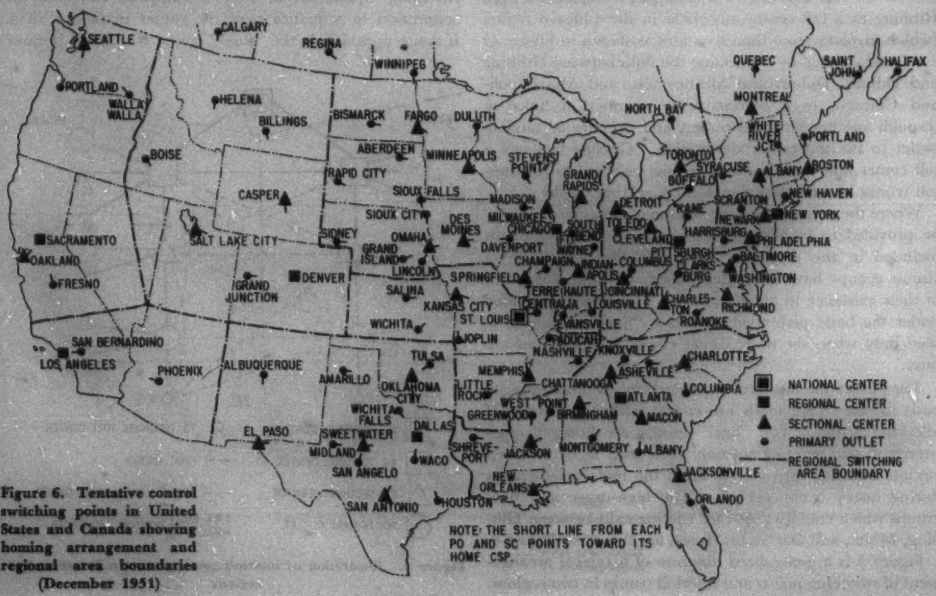

Figure 6. Tentative control switching points in United States and Canada showing homing arrangement and regional area boundaries (December 1951)

Figure 7. Cross section of cable containing four pairs of coaxials. Each pair can accommodate one 2-way coaxial carrier system

The general introduction of customer toll dialing as this becomes desirable will affect the number and location of ordinary toll centers since, in the ultimate, operators may be required only for assistance, person-to-person, collect, and other calls which can not be customer dialed. Studies now in progress indicate that the number of toll centers may be reduced by one-half or more over a period of years in many areas.

The expanded general toll switching plan for nation-wide dialing, using a nation-wide numbering plan,[6] contemplates a degree of alternate routing far in excess of that used with the former switching plan designed for manual operation. This change, along with the reduction in toll centers, will have a marked effect on the normal flow of many traffic items through the intertoll network. As a result, the arrangement of the present intertoll trunks will be significantly modified as to number, routing, and terminating points. It is necessary to take these facts into account in engineering toll plant additions so that they will lead toward an advantageous layout for future nation-wide dialing as well as meet the needs of the more immediate future. Fortunately, the effect is in the direction of greater concentration of circuits in main routes so that with the new cable and radio facilities available, over-all economy and better service should result.

TYPES OF TRANSMISSION FACILITIES USED AND INCLUDED IN SWITCHING PLAN

THE DOMESTIC toll network is an outgrowth of the demands of the business and the advance in communication technique over many years. At present, about 100,000 intertoll trunks over 25 miles in length and many thousand shorter toll trunks are in service throughout the country. They are provided by voice-frequency or carrier-frequency facilities. The type of transmission facility used on a given route is dependent on a number of factors, such as cost, length of haul, number of trunks in the cross section, number of trunks to be terminated at intermediate points, the types of terrain to be traversed, storm and other conditions affecting service continuity, and the transmission requirements of the circuits to be provided. Reliability is always stressed.

Voice-frequency facilities equipped with repeaters as required are provided on both open-wire lines and cables. In general, the use of voice-frequency facilities is now limited to shorter circuits.

Considerations of economy and service improvement lead rapidly to the introduction of carrier operation into all types of toll plant. This directly affects the toll switching plan from the standpoint of routing and location of switching centers. At present, carrier systems use four broad categories of facilities: open wire, conventional paired or quadded cables, coaxial cable, and radio.

Several types of open-wire carrier systems permitting from 1 to 15 telephone channels above the frequency band of the voice channel are now in use. In general, these systems are used where trunk cross sections are relatively small and where the terrain and weather conditions make open-wire lines economical.

Cable carrier systems presently permit the operation of up to 12 telephone channels on two pairs of cable conductors. These conductors may be in one cable or divided between two separate cables, depending on the type of carrier system. Coaxial-cable transmission systems currently provide up to 600 telephone channels per pair of coaxials. See Figure 7. A new coaxial system, under development, is expected to produce about 1,800 telephone channels per pair of coaxials.

Most of the applications of radio for toll telephone service now contemplated for heavy routes involve the use of point-to-point microwave systems. By employing channeling equipment at the terminals of these systems similar to that used for the present coaxial system, each pair of radio channels may provide up to 600 telephone channels. Several pairs of such radio channels may be operated through the same antennas. See Figure 8.

Radio systems are also useful in some cases where the number of toll trunks required is moderate, where route diversity is desired, or where water or other natural bar-

Figure 8. Microwave radio relay tower at Cotoctin Mountain, Md., on a New York–Washington radio route. There are 300 message circuits in service with more planned

riers make the provision of wire circuits difficult or impracticable. The type of facility to be used on a particular route is sometimes affected by requirements for other services such as teletypewriter, television network facilities, program facilities, private lines, and other factors.

About 70 per cent of the long-haul toll message mileage in Bell Operating Companies is provided on carrier-type facilities as contrasted with 7 per cent in 1930. See Figure 9.

From the transmission standpoint, carrier facilities offer marked advantages. They are inherently of the "4-wire" type which minimizes the number of possible singing and echo paths on a circuit. Also, the speeds of propagation over carrier systems are generally much higher than over voice-frequency systems, thereby further minimizing the echo problem. These features are of great advantage in reducing limitations on circuit design.

Intertoll trunks must be equipped with suitable facilities for signaling.[7,8] The arrangements employed must provide a means of: first, attracting the attention of the distant point, either an operator or automatic equipment, to the fact that a connection is to be established; second, in the case of dial operation, transmitting coded information in the form of pulses for establishing the connection; and third, transmitting a general class of supervisory signals including connect and disconnect signals, on and off switch hook signals, recall signals, and busy signals, which are essential to the efficient operation of the switching plant. The intertoll trunk design contemplated in the over-all plan must take into account this requirement for transmitting signals as well as speech, to insure accuracy and speed in setting up and taking down connections by operators or automatic switching equipment.

TRANSMISSION DESIGN ASPECTS OF CIRCUITS FOR NATION-WIDE TOLL DIALING

THE MORE EXTENSIVE use of alternate routing, together with the increase in maximum possible number of trunks in tandem associated with nation-wide toll dialing, tends to increase the problems of assuring adequate transmission of speech and signals on all possible connections. On the other hand, the use of 4-wire switching at important points and the definiteness of the routing patterns permit more effective use of the available facilities and thus tend to simplify the problem. Extensive studies indicate that, on the whole, the new toll switching plan will make still further improvements in transmission feasible. This is, of course, a desirable objective.

With dial operation, the number of trunks in tandem in a given toll connection may vary on successive calls. To avoid undesirable transmission contrasts and other adverse effects, it is important that every trunk be designed to operate as closely as possible to the theoretically correct transmission loss. The problem is complicated by the fact that the extent to which the echo, noise, and crosstalk will limit the performance of an individual link is not directly proportional to the length of the circuit. In fact, the minimum loss at which a particular circuit used singly or in various built-up combinations theoretically can be operated depends on the number, length, and characteristics of the other circuits connected in tandem with it. Arrangements for precisely adjusting the loss in the individual trunks for each call would be complicated. Adequate performance can be achieved, however, by compromise methods which provide for automatic adjustments in the loss of each trunk in accordance with the following:

1. When a trunk is switched to other intertoll trunks at both ends it is operated at the minimum loss practicable. This loss is known as "via net loss" (VNL).
2. When the trunk is switched to another intertoll trunk at one end only, the loss is increased 2 decibels.
3. When the trunk is not switched to another intertoll trunk at either end a further loss of 2 decibels is added. This loss, which is 4 decibels greater than the via net loss, is known as "terminal net loss" (TNL).

The data and methods used in the derivation of VNL are rather complex and not within the scope of this article.

The definite routing patterns established for the toll machine-switching operation impose more severe transmission requirements on certain classes of circuits than on others. For example, a trunk in a final group between a TC and a PO can become involved in an 8-link connection, whereas a trunk in a high-usage group, say, between two PO's normally will not be involved in more than a 3-link connection.

This creates a need and provides an opportunity for allocating the available facilities among the various trunk groups to provide the best over-all service. For example, to the extent practicable carrier grade facilities are assigned to trunks in final groups that may be involved in connections with the maximum number of links. Facilities with less favorable transmission characteristics then may be reserved for trunks in groups that are used for connections involving fewer links.

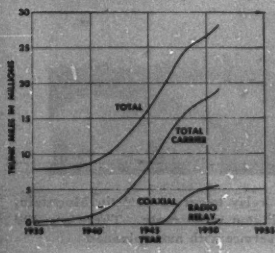

Figure 9. Growth in Bell System intertoll trunk mileage showing trend toward more extensive use of carrier-type facilities

Figure 10. Toll switchboard position with key set used for toll dialing

TRANSMISSION PERFORMANCE

TABLE I shows the approximate range of transmission losses between toll centers under the manual plan

compared to ranges that appear practicable under the proposed fundamental plan which, of course, permits more links in tandem.

Table I. Approximate Range of Losses Between Toll Centers in Decibels

No. of Links in Intertoll Connection	Manual Plan	Proposed Plan
1	4–12	4–8
2	8–14	5–12
5	4–20	6–13
8	—	7–13

It is as important that the transmission loss of a trunk used in the contemplated toll-dialing network be maintained at or close to its assigned value at all times as that the assigned value be right. On multiswitched connections even a relatively small consistent excess or deficiency in the loss in the individual trunks can accumulate to overall excesses or deficiencies in loss large enough to cause difficulty—by making it hard for people to hear if the attenuation becomes too great or by creating excessive echo, crosstalk, or noise, if the loss becomes appreciably less than normal.

Since, with operator toll dialing, only one operator is involved on most connections regardless of length or complexity, and with customer toll dialing there are no operators, it is extremely important that everything circuitwise be right at all times as machines must do much of the job. This is typical of the requirements of any large-scale "push-button" operation. See Figure 10.

CONCLUSION

THE FUNDAMENTAL PLANS proposed for telephone toll switching provide a basis for the progressive mechanization of toll service. The installation of suitable switching mechanisms at control switching points and the provision of toll trunks utilizing the new instrumentalities will implement the toll switching plan. The plan is sufficiently flexible to adjust for changes in the telephone art as they develop. Also, the plan can fit in with the requirements of those companies whose plants connect with the Bell operating network should they desire to arrange for operator or customer toll dialing.[9]

Average speed of service will be improved. The flexibility in plant design inherent in the new toll-switching plan will increase service security and improve the utilization of the entire toll plant. In addition, adequate provision is made for the progressive introduction of customer toll dialing as this becomes practicable and desirable.

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First Railroad Ferry Radar in New York Harbor Installed

The first railroad ferry radar in New York harbor has been installed aboard the Jersey Central Lines ferry by Radiomarine Corporation of America. The ferry model is a special adaptation of the standard radar designed especially for harbor craft, trawlers, fishing boats, ferries, and yachts, to help cut down costly fog delays in the harbors.

On the ferry installation, special switching features allow indicators in both pilot houses to be used alternately by means of complete controls for each house. Both indicators are connected to one transmitter-receiver. The antenna is mounted on a 25-foot aluminum tower, high enough to provide an unobstructed 360-degree view.

The compact harbor-craft radar has a 30-kw transmitter operating on a wavelength of 3.2 centimeters. It has the power and sensitivity to pick up ships or landmarks from 75 yards to 20 miles.

One important feature of the unit is its adaptability to any ship's power supply. The equipment can be supplied to operate from 24, 32, 115, or 230 volts direct current or from 60-cycle alternating current of 115 or 230 volts.

The complete radar installation for ferryboats consists of four basic units: two indicators, a transmitter-receiver, and an antenna assembly. The indicators can be compactly mounted either overhead, on a shelf, or on a table, depending on the size and layout of the wheelhouse.

The antenna, which weighs 150 pounds, is slotted throughout its 50-inch length to reduce wind drag, and all gears are enclosed in a weathertight aluminum casing.

Jersey Central ferries make an average of 250 trips daily over the 1-mile course between Jersey City, N. J., and Liberty Street, New York. The addition of radar to the standard equipment on the boats will aid the line in maintaining its performance record and giving passengers more assurance of dependability and safe operation.

Ultrathin Magnetic Alloy Tapes With Rectangular Hysteresis Loops

M. F. LITTMANN

The principal soft magnetic alloys have been rolled to thicknesses between 1/8 and 1 mil. This study was restricted to those metal tapes having high permeability and a relatively high resistivity to minimize eddy-current effects.

THE CONTINUING need for magnetic core materials which can be used effectively at high frequencies has stimulated the search for materials in which eddy-current effects produced by rapid changes in magnetic flux are at a minimum. Generally speaking, there are two ways in which eddy-current effects can be reduced: to increase the electrical resistivity as in the ferrites, or to restrict the paths in which eddy currents can flow as in powdered metals or thin laminations of metal strip.

The ferrites, which have resistivities about 10^8 to 10^{12} higher than conventional magnetic alloys, have been used extensively in television sweep transformers where they may be operated at high frequency with low power loss.[1] However, such characteristics as relatively low magnetic saturation, low Curie point, and certain dielectric properties, particularly for larger masses, restrict the scope of application of the ferrites. On the other hand, the fine subdivision of particles in powdered metal cores results in very low d-c permeability even for the best alloys. Where high permeability is desirable, very thin metal tapes are useful and these are the basis of the present article.

The commercial use of magnetic alloys rolled to thin gauges grew very rapidly during World War II. For power transformers, laminated or tape-wound cores of strip 4 to 6 mils thick were employed, and for radar pulse transformers, cores of 1- to 3-mil thick material were used. This large-scale use of thin materials was, to a large degree, the result of development of economical methods of rolling 1- to 6-mil strip, primarily silicon-iron, in quantities of thousands of pounds. Already during this period there were some applications involving rates of magnetization so high that materials even thinner than 1 mil (0.025 millimeter) were required. Small quantities of *4–79* Permalloy tapes 1/4 mil thick were rolled on a small mill at the Bell Telephone Laboratories for such applications.[2] The production of magnetic alloys in tapes as thin as 1/8 mil now has been undertaken by commercial organizations.

Since 1950 four different alloys have been rolled to gauges less than 1 mil and fabricated into toroidal cores. The descriptive term "ultrathin" has been applied to these materials. The alloys chosen for study are commonly used soft magnetic materials having high permeability. The group was restricted to those alloys having relatively high resistivity in order to keep eddy-current effects to a minimum. The values of magnetic saturation, Curie temperature, and volume resistivity, as shown in Table I,

Figure 1. Coil of cold rolled 48-per-cent nickel-iron alloy 1/4 mil thick, and ceramic bobbins

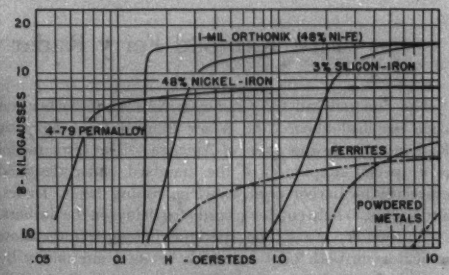

Figure 2. D-c magnetization curves of 1/4-mil ultrathin metal tapes compared with other materials used at high frequencies

Full text of paper 52-208, "Ultrathin Tapes of Magnetic Alloys With Rectangular Hysteresis Loops," recommended by the AIEE Committees on Magnetic Amplifiers and Basic Sciences and approved by the AIEE Technical Program Committee for presentation at the AIEE Summer General Meeting, Minneapolis, Minn., June 23–27, 1952. Scheduled for publication in AIEE *Transactions*, volume 71, 1952.

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Table I. Basic Properties of Alloys Investigated

	3 Per Cent Silicon, Balance Iron	48 Per Cent Nickel, Balance Iron	79 Per Cent Nickel, 4 Per Cent Molybdenum, Balance Iron	79 Per Cent Nickel, 5 Per Cent Molybdenum, Balance Iron
Magnetic saturation, gausses	20,000	16,000	8,700	8,000+
Curie temperature, degrees centigrade	700	440	420	400
Resistivity, microhm-centimeters	47	45	55	60
Density, grams per cubic centimeter	7.65	8.25	8.72	8.77

are characteristic of the alloys themselves and probably do not change with thickness in the range of 1 mil to 1/8 mil.

The alloys were rolled as single strands in a width of 2 inches employing work rolls of very small diameter. After rolling, the strip was slit into ribbons 1/8 or 1/4 inch wide for winding into toroidal cores. Because of the fragile nature of small toroidal cores, often consisting of only a few wraps of tape, it was advantageous to wind the cores on ceramic bobbins as shown in the foreground of Figure 1. The bobbins furnished support for the tape during annealing and also provided a frame for the copper windings used in testing. The tape was insulated with a magnesia coating prior to annealing. Annealing was conducted in very dry, pure hydrogen at temperatures from 875 to 1,150 degrees centigrade. The particular magnetic properties obtainable depend not only on the composition of the alloy, but on the processing steps of the metal supplier, the forming and annealing procedure used by the fabricator, and the stresses and temperature to which the core may be subjected after it is completed. These factors, individually or collectively as the case may be, all contribute to the resistivity, crystal and domain orientation, and stresses present in the lattice structure of the completed core. They thus govern the characteristics of the core material when a magnetomotive force is applied. It naturally would be most difficult to present a detailed picture of the magnetic properties of ultrathin magnetic alloys at this early stage of development. The purpose of this article is to present a general picture of the type of magnetic characteristics we may expect under d-c magnetization as determined by the ballistic galvanometer. The measurements were made at room temperature with the flux parallel to the rolling direction of the strip.

The d-c permeability, particularly at high inductions, of ultrathin metal tapes is very much higher than for other materials used for high frequencies, as shown in Figure 2. It may be noted that the d-c magnetization curves for the 1/4-mil tapes are very similar to those for the same alloys in the more familiar thicknesses of 1 to 14 mils. For comparison, the magnetization curve is shown for a specimen of 1-mil grain-oriented 48-per-cent nickel-iron having a very rectangular hysteresis loop. Rectangular hys-

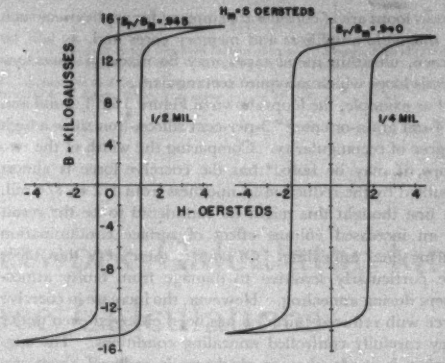

Figure 3. D-c hysteresis loops of grain-oriented 3-per-cent silicon-iron

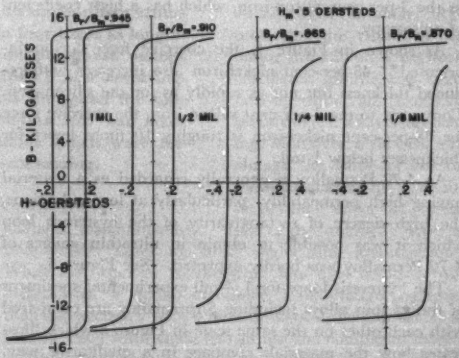

Figure 4. D-c hysteresis loops of grain-oriented 48-per-cent nickel-iron

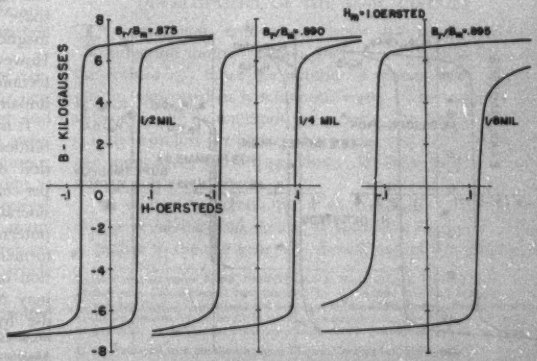

Figure 5. D-c hysteresis loops of 4-79 Permalloy showing pronounced rectangularity

teresis loops are of considerable interest for applications such as magnetic amplifiers and memory cores and, as will be shown, ultrathin metal tapes may be made to have hysteresis loops which are quite rectangular.

For example, the loops shown in Figure 3 for 1/2-mil and 1/4-mil grain-oriented* 3-per-cent silicon-iron show a high degree of rectangularity. Comparing the width of the two loops, it may be noted that the coercive force is almost doubled by the reduction in thickness from 1/2 to 1/4 mil. At first thought this might be considered to be the result of an increased volume effect of surface contamination during final annealing. Of course, these very thin tapes are particularly sensitive to damage from faulty atmosphere during annealing. However, the increase in coercive force with reduced thickness has been observed even under very carefully controlled annealing conditions. The suggestion is made that as thickness is reduced there are changes in domain size and shape which cause an increase in coercive force. A contributing factor may be the type of crystal orientation present, particularly for material such as the 3-per-cent silicon-iron, which has a high coefficient of anisotropy.

As shown in Figure 4, the coercive force for grain-oriented** 48-per-cent nickel-iron also increases with reduced thickness but not as rapidly as for the silicon-iron. Compared to the 3-per-cent silicon-iron, the coercive force for 48-per-cent nickel-iron is roughly 10 times lower for thicknesses below 1 mil.

As *4–79* Permalloy is generally regarded as a material having high permeability, particularly at low inductions, the high degree of rectangularity of the hysteresis loop which it was possible to obtain in ultrathin gauges of *4–79* Permalloy was hardly expected. See Figure 5.

The hysteresis loops for 1/4-mil experimental specimens of the various alloys including Supermalloy are compared with each other on the same scale in Figure 6 which illustrates how the materials compare in a qualitative way. The comparison is intended to be on a qualitative basis since it will be understood that the properties for each alloy can be varied considerably and the particular specimens

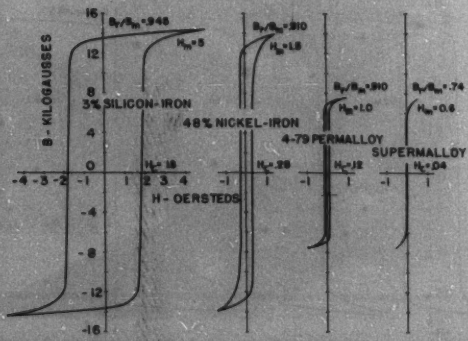

Figure 6. Comparison of hysteresis loops for ultrathin magnetic alloys 1/4 mil thick. Data plotted to same scale

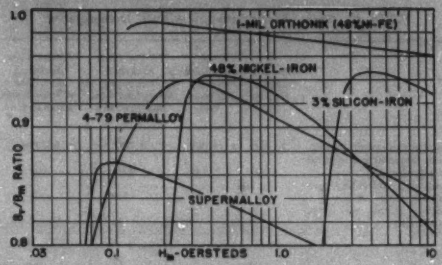

Figure 7. Variation of ratio of residual to maximum induction with magnetizing force for 1/4-mil cores with rectangular hysteresis loops. Data for 1-mil grain-oriented 48-per-cent nickel-iron included for comparison

for which data are presented here were chosen because their hysteresis loops were quite rectangular. Again referring to Figure 6, the various shapes of loops illustrate that the terms "square loop" or "rectangular hysteresis loop" are, at best, only descriptive, and that important differences in degree exist depending on the criteria used. Such criteria may be the slopes of the sides of the loops, or the slope of the top of the loop as saturation is approached.

One useful way of measuring rectangularity is to note how the ratio of residual to peak or maximum induction, B_r/B_m, varies with peak or maximum magnetizing force, H_m. The curves for H_m versus B_r/B_m shown in Figure 7 represent the same cores used for Figure 6 and Figure 2. Lower ratios of B_r/B_m may be achieved by variation of processing and annealing treatments. Very low ratios may be obtained by the introduction of a small air gap into the magnetic path. Supermalloy is the only material among those studied here in 1/4 mil thickness which has not been found thus far to display a maximum ratio of B_r/B_m greater than 0.9.

The space factor or packing factor present in the experimental cores used for the tests described is as low as 50 per cent for 1/4-mil strip. For small cores containing only a few turns of strip, space factor is not a limitation. Where space and weight are limiting factors, the thickness of magnesia insulation probably would be a handicap. However, there is considerable promise that improved techniques may permit much higher space factors without impairing the value of the insulation.

It is too early to state in detail what the potential capabilities of these ultrathin materials are under pulse excitation or continuous high-frequency operation. The 48-per-cent nickel-iron and *4–79* Permalloy tapes show considerable promise for high-speed memory cores in computers. For magnetic amplifiers and radar pulse transformers, the low coercive force and high magnetic saturation of ultrathin alloy tapes are of interest, although it may not necessarily be desirable to have a rectangular d-c hysteresis loop. Ultrathin *4–79* Permalloy appears

* Substantially that of a single crystal with a cube edge in the rolling direction and a face diagonal in the transverse direction.

** Substantially that of a single crystal with a cube edge both in the rolling and transverse directions.

to be particularly attractive since it has relatively high volume resistivity and can be made to have either a rectangular or "rounded" d-c hysteresis loop together with low coercive force.

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MONECA—A New Network Calculator for Motor Performance Calculations

C. G. VEINOTT
FELLOW AIEE

Performance calculations on single-phase induction motors require two to four times as long as comparable calculations on polyphase motors. A new calculator based upon a new revolving-field equivalent circuit has shortened the time for making these calculations and has made practicable many calculations which were formerly too time-consuming.

AMERICAN prosperity is undoubtedly due in large part to the tools that have been developed to relieve the drudgery and to increase the productivity of human labor. Over the course of many years, the engineer has perfected machines to do all kinds of manual labor, and even has mechanized arithmetical and accounting procedures. But only recently has the engineer devoted similar efforts to taking the same drudgery out of his own tasks in order to increase his own productivity. In the last decade scores of computers of all kinds have been developed for a wide variety of applications. Generally speaking, these computers exceed human capabilities principally in the speed at which they perform the operations that could be done otherwise, if time were available. By accelerating the speed of these computations fabulously, they make practicable and worth while many calculations that would not otherwise be made. These same remarks apply generally to the special-purpose computer described in this article.

Single-phase motors comprise the large majority of electric motors being made today. Curiously enough, performance calculations on them are more involved and more time-consuming than similar calculations on polyphase motors. On the running connection, for example, it takes at least twice as long to calculate a single point as it does for a polyphase motor. On the starting connection, it takes at least four times as long. As a consequence, many calculations that should be performed are left undone. For these reasons, the calculator described in this article was developed.

An analogue-type computer was felt to be better suited to this application than a digital type, for a number of reasons. There has been a decided trend, in recent years, to the development of machine theory in terms of networks; many such networks, therefore, could be set up directly on a network computer. Reproducing the circuit of the motor directly on a network calculator affords the engineer-operator an excellent picture of just what is happening. Moreover, if he wishes to change the value of one or more constants, he can observe the effect of these changes instantaneously. Hence, the analogue type is undoubtedly faster for most engineering investigations. While the accuracy is somewhat less than could be obtained with a digital computer, it is probably greater than the accuracy with which he knows the constants, or the accuracy with which he can test the completed motor.

While many circuits have been published for many types of machines, the basic circuit around which MONECA* was developed is believed to be new and never before published.

DEVELOPMENT OF THE BASIC CIRCUIT

THE CLASSICAL equivalent circuit for the polyphase induction motor is shown in Figure 1. Watts loss in the resistor r_2/s times the number of phases is the output torque, expressed in synchronous watts. The input to the network is the motor input per phase. The loss in resistor r_f is the iron loss per phase; the voltage across it is the voltage induced by the air-gap flux. All these facts are well known and established.

An equivalent circuit for a single-phase motor, based on the revolving-field theory, is shown in Figure 2. This is similar to the one generally shown, except for treatment

Revised text of paper 52-50, "MONECA—A New Network Calculator for Motor Performance Calculations," recommended by the AIEE Rotating Machinery and Computing Devices Committees and approved by the AIEE Technical Program Committee for presentation at the AIEE Winter General Meeting, New York, N. Y., January 21–25, 1952. Scheduled for publication in the AIEE *Transactions*, volume 71, 1952.

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The author acknowledges the many contributions made by R. B. Squires, who designed the calculator to incorporate the features described, and many others.

* MONECA is a name coined from MOtor NEtwork CAlculator.

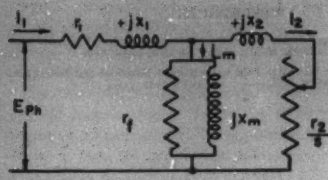


Figure 1. Equivalent circuit of a polyphase motor

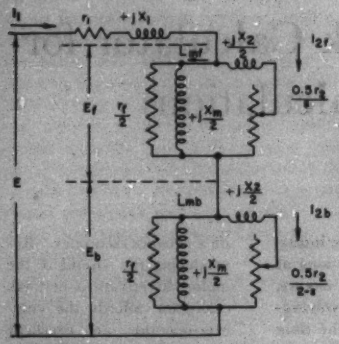


Figure 2. Revolving - field equivalent circuit of a single-phase induction motor

of the iron loss. In this circuit, iron loss is represented for both the forward and backward fields by two resistors bridged across the mutual reactances for the two fields, in the same manner as iron loss is handled in Figure 1. Most writers take care of iron loss either by adding the total value to the input or by subtracting it from the output. Handling it as shown in Figure 2 would entail a prodigious and unwarranted amount of labor in the performance calculations if these were made manually. Theoretically, it is probably more correct to handle iron loss as shown in Figure 2, and since it can be done on a network calculator, it has been set up that way on this one. In all candor, however, it must be admitted that this arrangement is born, in part, of necessity since it is not possible to build the magnetizing reactors without losses anyway. By adding supplementary resistors $r_f/2$, it becomes possible to adjust them to correspond to the iron loss. In Figure 2, the loss in resistor $0.5r_2/s$ is the forward-field torque, and the loss in resistor $0.5r_2/(2-s)$ is the backward-field torque. Similarly, E_f and E_b represent the voltages induced in the stator winding by the forward and backward fields, respectively. Except for treatment of the iron loss, this circuit is well known and generally understood. It is reproduced in simpler block form in Figure 3.

Now, consider a single-phase motor with two separate and distinct windings in space quadrature, as shown in Figure 4. These windings need not have the same number of turns; in fact, they rarely do. Usually the same voltage is impressed on both windings, though different voltages are shown in the figure to make the derivation more general. Rotation is shown as counterclockwise because rotation is normally from the auxiliary winding towards the main winding. Each winding sets up two revolving fields, making four in all. These four fields induce voltages in their own respective windings as follows:

$$\begin{aligned} E_{fm} &= I_{1m}Z_f \\ E_{bm} &= I_{1m}Z_b \\ E_{fa} &= I_{1a}K^2Z_f \\ E_{ba} &= I_{1a}K^2Z_b \end{aligned} \qquad (1)$$

where K = ratio of effective turns in auxiliary winding to effective turns in main winding.

In addition, the following voltages are induced in the main winding:

By the forward auxiliary field

$$\frac{-jI_{1a}K^2Z_f}{K} = -jKI_{1a}Z_f \qquad (2)$$

By the backward auxiliary field

$$\frac{+jI_{1a}K^2Z_b}{K} = +jKI_{1a}Z_b \qquad (3)$$

Also, the following voltages are induced in the auxiliary winding:

By the forward main field

$$+jKI_{1m}Z_f \qquad (4)$$

By the backward main field

$$-jKI_{1m}Z_b \qquad (5)$$

The total voltage induced in each winding is the sum of all the individual voltages which can be obtained by adding the proper voltages from the foregoing equations to the primary impedance drops, obtaining

$$E_m = I_{1m}Z_{1m} + I_{1m}Z_f - jKI_{1a}Z_f + I_{1m}Z_b + jKI_{1a}Z_b \qquad (6)$$

$$E_a = I_{1a}Z_{1a} + I_{1a}K^2Z_f + jKI_{1m}Z_f + I_{1a}K^2Z_b - jKI_{1m}Z_b \qquad (7)$$

These are the two fundamental simultaneous equations for the capacitor motor which were developed by Morrill[1] in a similar fashion, though his are given in slightly different notation. In their present form, however, they do not lend

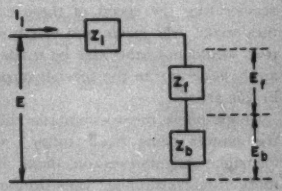


Figure 3. Equivalent circuit of a single-phase induction motor in simplified form

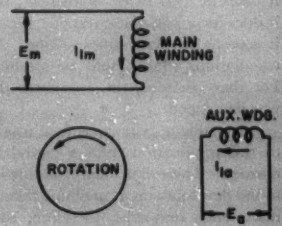


Figure 4. Schematic representation of single-phase motor with two windings in space quadrature

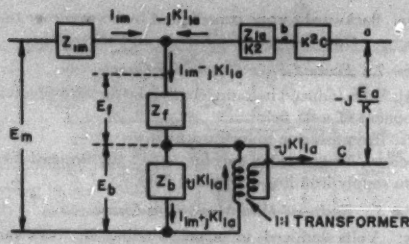


Figure 5. Equivalent circuit of a capacitor motor with windings in space quadrature

themselves readily to the development of an equivalent circuit. But their form can be changed.

Rewriting equation 6 to combine terms

$$E_m = I_{1m}Z_{1m} + (I_{1m} - jKI_{1a})Z_f + (I_{1m} + jKI_{1a})Z_b \qquad (8)$$

Multiplying both sides of equation 7 by $-j/K$ and grouping terms

$$-jE_a/K = -jKI_{1a}Z_{1a}/K^2 + (I_{1m} - jKI_{1a})Z_f - (I_{1m} + jKI_{1a})Z_b \qquad (9)$$

Figure 5 shows an equivalent circuit developed from these equations. It represents the single-phase induction motor with windings in space quadrature, because the simultaneous equations for the solution of this network are equations 8 and 9, as can be seen by inspection. Figure 5 represents schematically the circuit around which the calculator MONECA was designed. So far as the author is aware, this circuit has never before been published.

CONSTRUCTION AND OPERATION

Figure 6 is an illustration of the MONECA. A detailed schematic diagram is reproduced in Figure 7, which is mounted on the calculator, just to the right of the operator, under a Plexiglas window. It is of great assistance to a novice operator in helping him to know which switches to throw, and to grasp the significance of his readings more readily. One set of electronic low-loss meters is used for all readings in all circuits. Circuits themselves are located on removable panels above the operator; their control knobs are on the panels. Two voltage sources are provided; voltage and phase of these voltages can be controlled independently. Leads from all these circuits and voltage sources are brought out to the connection panel at the operator's right, below the extension leaf. The instruments are connected to any desired circuit by means of the switches located on the sloping panel, between the schematic circuit and the meters themselves. To the left of the instruments are metering control switches: these select any one of three voltage scales, any one of five current scales; they also control wattmeter polarity, and likewise permit use of the wattmeter to read watts or vars, or either amperes or volts in vector form, giving the answers either in rectangular or polar co-ordinates. An extension leaf is provided at the operator's right to support his data sheet when recording readings. All dials and controls, except those for the magnetizing reactances, can be reached by the operator while sitting in his chair. Since the magnetizing reactance is seldom changed in the course of a motor performance calculation, most calculations can be performed and recorded by the operator without his moving from his chair. All circuits are numbered and also identified by removable cards on the panels where they are located; these same identification numbers appear on the schematic diagram, reproduced in Figure 7, right opposite the circuit-selector switches. A listing of the meaning of each of these readings gives a good idea of what can be obtained from the calculator.

When the calculator is connected according to the circuit reproduced in Figure 7, the significance of each of the readings in each circuit is as follows:

G1. Main-Winding Source

Volts: Volts input to main winding.
Watts: Watts input to main winding.
Amperes: Current input to main winding.

G2. Auxiliary-Winding Source

Volts: Volts input to auxiliary winding, in terms of main winding.
Watts: Watts input to auxiliary winding.
Amperes: Current input to auxiliary winding, in terms of main winding. (Voltage and current are displaced 90 degrees in time phase from what they are in the motor being calculated. When reading scalar values, this phase displacement is of no consequence. When reading in vector form, this phase displacement has to be taken into account.)

Number 1. Primary Impedance of Main Winding

Volts: Primary impedance drop in main winding.
Watts: Main-winding copper loss.
Amperes: Main-winding current input.

Number 2. Primary Impedance of Auxiliary Winding, Referred to Main Winding

Volts: Primary impedance drop in auxiliary winding, in terms of main winding.
Watts: Auxiliary-winding copper loss.
Amperes: Auxiliary-winding current, in terms of main winding. (See parenthetical note on G2.)

Figure 6. MONECA in operation. Starting at the top of the left-hand row of panels, controls are for: magnetizing reactances; primary windings; rotor circuits; and extended ranges for rotor circuits and iron-loss control. The middle panels, from top to bottom, are: blank, for future use; bottom-cage rotor circuits; main-winding generator G1; metering system controls. Right-hand panels: blank, for future use; capacitor; auxiliary-winding generator; winding-connection switch SC and line switch

Number 3. Forward-Field Rotor Circuit

Volts: Volts induced in main winding by forward-revolving component of total field.

Watts: Torque developed by forward field, in synchronous watts.

Amperes: Slip-frequency component of rotor current, in terms of main winding; that is, current induced in rotor by forward field.

Number 4. Backward-Field Rotor Circuit

Volts: Volts induced in main winding by backward-revolving component of total field.

Watts: Torque developed by backward field, in synchronous watts.

Amperes: Component of rotor current having a frequency of (2-*s*) times line frequency, in terms of main winding; that is, current induced in rotor by backward field.

Number 5. (*Double-Cage Rotors Only*)

Bottom-Cage Circuits, Forward Field.

Watts: Forward torque contributed by bottom cage only.

Amperes: Slip-frequency current in bottom cage, in terms of main winding.

Number 6. (*Double-Cage Rotors Only*)

Bottom-Cage Circuit, Backward Field.

Watts: Backward torque contributed by bottom cage only.

Amperes: Double-frequency current in bottom cage.

Number 7. Forward-Field Magnetizing Circuit

Volts: Volts induced in main winding by forward-revolving component of total field.

Watts: Iron loss due to forward field.

Amperes: Magnetizing current to set up forward field, and to supply iron loss of forward field.

Number 8. Backward-Field Magnetizing Circuit

Volts: Volts induced in main winding by backward-revolving component of total field.

Watts: Iron loss due to backward field.

Amperes: Magnetizing current to set up backward field, and to supply iron loss of backward field.

C1. Capacitor Circuit

Volts: Volts across capacitor, in terms of the main winding.

Watts: Watts loss in the capacitor.

Amperes: Current through the capacitor, in terms of the main winding.

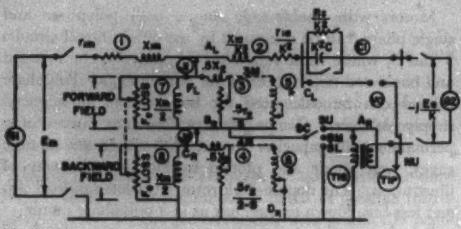
J1. Forward-Sequence Bus

Amperes: The forward-sequence component of total stator current. It is equal to $I_{1m} - jKI_{1a}$. This current sets up the total forward-revolving magnetomotive force; part of

Table I. MONECA Calculation and Data Sheet for Single-Phase Induction and Capacitor Motors

1/2 Horsepower, 115 Volts, 6 Poles, 60 Cycles

$E_m = 115.0$		$E_a = 115.0$		$K = 1.215$		$E_a/K = 94.5$		$E_a/K^2 = 77.9$			$C = 400$ mfd		
$x_{1m} = 0.08 \mid 1.52$		$r_{1m} = 0.77$		$X_{1a}/K^2 = 0.01 \mid 1.94$		$r_{1a}/K^2 = 2.34$		Cap. pf = 8%			$K^2C/60 = 590$		
$0.5x_2 = 0.04 \mid 0.76$		$0.5r_{2m} = 13.5$		$0.5r_2 = 0.72$		Iron loss = 50		Friction & Windage = 11.3			Bd. Mult. 100		
	MONECA	**No Load**	**Full Load**	(C)	(C)	(C)	**S.O.S.(m)**	**S.O.S.(c)**	**m**	**Locked**
					Speed-Torque Curve								
1.	s = slip		0.0019	0.0342	0.80	0.60	0.40	0.20	0.20	0.10	1.0
2.	2-s		2.0	1.968	1.20	1.40	1.60	1.80	1.80	1.90	1.0
3.	$0.5r_2/s \mid 0.04$	set:3	380	21.04	0.90	1.20	1.80	3.6	3.6	7.2	0.72
4.	$0.5r_2/s(2-s) \mid 0.04$	set:4	0.36	0.365	0.60	0.514	0.450	0.40	0.40	0.379	0.72
5.	Friction & windage (syn. watts)		11.3	11.3	11.3	11.3	11.3	11.3	11.3	11	11.3
6.	T_b =	W:4	16	22	112	154	225	146	400	62	91
7.	⑤ + ⑥		27	33	123	165	236	157	411	73	102
8.	T_f =	W:3	27	418	2,025	2,275	2,460	1,270	2,270	960	1,800
9.	T = ⑧ − ⑦ (syn. watts)		0	385	1,902	2,110	2,224	1,113	1,859	887	1,698
10.	Torq.-oz.-ft.		0	36.1	179	198	209	104.5	175	83.3	159.5
11.	Rpm.		1,197.8	1,159	240	480	720	960	960	1,080	0
					Performance								
12.	Output = ⑤ × (1 − s)		0	373							
13.	Mn. ph. watts	W:G1	130	540							
14.	Aux. ph. watts	W:G2									
15.	Line watts			540							
16.	Eff. = ⑫ / ⑭			69.0							
17.	Main ph. A = I_{1m}	A:G1	7.2	8.6							
18.	KI_{1a}	A:G2									
19.	Aux. ph. A = I_{2a} = ⑱ / K										
20.	Power factor			54.6							
21.	Wdg. volts / K =	V:VO		116	115	118	129	98.5	154		
22.	Cap. volts / K =	V:C1			96	87.2	79		82.6	(c)100.5	103.5
23.	Wdg. volts = K × ㉑				140	143.5	157	120	187		
24.	Cap. volts = K × ㉒				116.8	106	96		100.5	(c)122	126
					Segregation of Losses								
25.	Copper loss (m)	W:1	38	52							
26.	Copper loss (a)	W:2	0	0							
27.	Capac. loss	W:C1	0	0							
28.	Iron loss (f)	W:7	50	50							
29.	Iron loss (b)	W:8	0	0							
30.	Sec. I^2R(f) = s × ⑧		0	14							
31.	Sec. I^2R(b) = (2 − s) × ⑧		32	43							
32.	Friction & windage = ⑤ × (1 − s)		11	11							
33.	Total losses		131	170							
34.	Losses + output		131	543							
35.			1	2	3	4	5	6	7	8	9



Note: Dot indicates positive end of circuit
**For double-deck rotors only.*

Figure 7. Schematic diagram of calculator for revolving-field setup. The nomenclatures in circles are the circuit designations on the calculator. Designations like A_L and F_L at circuit junctions denote bus connections where circuits are joined by flexible leads on the lower right-hand side of the calculator

this current is magnetizing current (circuit 7) and part of it overcomes the rotor magnetomotive force (circuit 3).

J2. Backward-Sequence Bus

Amperes: The backward, or negative-sequence, component of stator current. It is equal to $I_{1m}+jKI_{1a}$. This current sets up the total backward-revolving magnetomotive force; part of this current is magnetizing current (circuit 8) and part of it overcomes the rotor magnetomotive force (circuit 4).

VO. Auxiliary-Winding Bus

Volts: The voltage across the auxiliary winding, in terms of the main winding. (See parenthetical note on G2.)

Procedure for setting up for a calculation is best illustrated by reference to Table I, which is a reproduction of an actual set of calculations made upon a 1/2-horsepower capacitor-start motor. First, the known design constants are recorded in the proper blanks at the top of the sheet. (The bracketed figure 0.08, appearing in the x_{1m} space, represents the ohmic resistance of the x_{1m} reactor; hence, in setting up r_{1m} on the board, the value set up is equal to the actual value desired less the 0.08.) To set up the iron loss, the resistors in circuits 3 and 4 are set for synchronous speed, that is, with circuit 3 open, and circuit 4 at $0.5r_3/2$. Only the main-winding circuit is energized, and the iron-loss potentiometers, which are ganged together, are adjusted so that the wattmeter, when connected to circuit 7, reads the iron loss of 50 watts. (At no load, virtually all of the iron loss is due to the forward field.)

Procedure for calculating a load point is most easily explained by describing the procedure for filling out the third column of Table I, where the slip is 80 per cent. Numerical values for r_2/s and $r_3/(2-s)$ are computed by slide rule and entered on lines 3 and 4, respectively. The resistance in circuit 3 is then adjusted to $0.90-0.04=0.86$, and the resistance in circuit 4 to 0.56. These are the only two settings that have to be made for any one slip. Now, if only speed-torque characteristics are desired, it is necessary to read only watts in circuit 4 and watts in circuit 3, as indicated by the symbols "W:4" and "W:3" on lines 6 and 8 in the column headed "MONECA." Torque and speed are readily computed from these readings by completing the blank spaces through line 11. In this particular instance, the operator was interested in the volts across the auxiliary winding—in case it was desired to use a voltage-operated relay—and also the voltage across the capacitor itself—to see that it was not great enough to damage the capacitor. Therefore, the readings for lines 21 and 22 were taken and the desired voltages computed and entered in lines 23 and 24. At a slip of 20 per cent, calculations were made with both windings in the circuit and recorded in the column headed "(c)"; they were repeated for main winding only and recorded in the column headed "(m)." In the latter instance, it was not necessary to reset circuits 3 and 4; instead the switch for *G2* was opened and the single-pole switch *SC* in Figure 7 was opened.

When slip is the independent variable, the whole process is direct and straightforward, as described heretofore. To compute either no load, or full load directly, a slight cut-and-try process is involved. A similar cut-and-try process is involved when the equivalent circuit method is used manually, except that the process is ever so much faster on the calculator. This process will be described first for the no-load point.

For no load, circuits 3 and 4 are first set for synchronous speed, which is with circuit 4 at 0.36 ohm, in this instance, and circuit 3 open. "W:4" read 16, which was tentatively entered in line 6 and added to the friction and windage of 11, obtaining 27, which is the total negative torque that has to be overcome by the forward field. Meters were switched to circuit 3, and starting with a high value, the resistance was adjusted downward until "W:3," the forward torque, was 27. This is the no-load point, for the output torque is zero. No-load slip is determined by dividing 380 into 0.72, obtaining 0.19 per cent. With the circuits set thus, all other desired quantities were read. In this motor, capacitor-start motor, all these adjustments and readings were done with the auxiliary winding out of the circuit. They are no more difficult nor time-consuming to perform for a permanent-split capacitor motor; it is necessary only to have the auxiliary winding in the circuit when the steps are done.

Full-load output can be hit exactly by a similar cut-and-try process. Full-load slip is first assumed and the calcu-

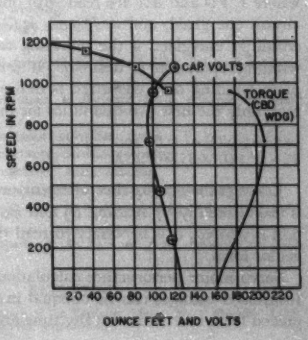


Figure 8. Speed-torque characteristics of a typical 1/2 - horsepower capacitor-start motor, plotted from the data of Table I

lator is set up accordingly. Resistance in circuit 3 is then adjusted so that "W:3" reads the right amount for full-load output. (This is full-load torque, in synchronous watts, plus item 7.) This same process is equally applicable to permanent-split capacitor motors, and no more difficult to use.

Performance curves, plotted from Table I, are given in Figure 8.

OTHER USES OF THE CALCULATOR

LINE AMPERES, on the starting connection, cannot be read directly on the calculator. One way to determine it is to determine the real and quadrature components of the currents in each of the windings and to add them manually. Another way, which is somewhat simpler, is to read the vars input to each winding as well as the watts input to each winding. The line amperes is then

$$I_L = \frac{\sqrt{(W_m+W_a)^2+(V_m+V_a)^2}}{E} \qquad (10)$$

Locked-rotor amperes, however, can be read directly, because then $Z_f = Z_b$. To do this, the voltage and phase of *G2* are adjusted to E_a/K^2. Then, the current flowing in this circuit is I_{1a}, not $-jKI_{1a}$. Current in the *J1* jumper is equal to the vector sum of main and auxiliary winding currents, that is, the line current. Hence, locked-rotor amperes can be read directly. This procedure is valid only at standstill where $Z_f = Z_b$.

Pulsating torque can be determined by taking only a few more readings on the calculator. It is shown in Appendix I (see AIEE *Transactions*) that the double-frequency pulsating torque, expressed in synchronous watts is given by

$$T_p = (Z_f - Z_b)(I_{1m} - jKI_{1a})(I_{1m} + jKI_{1a}) \qquad (11)$$

At any slip, with main-winding circuit only energized, it is apparent by inspection of the circuit of Figure 7, or by letting $I_{1a} = 0$ in equation 9, that

$$Z_f - Z_b = \frac{\text{auxiliary winding, volts}}{\text{main winding amperes}} / K \qquad (12)$$

Hence the pulsating torque, in term of board quantities, becomes

$$T_p = \frac{(V{:}VO)}{(A{:}1)}(A{:}J1)(A{:}J2) \qquad (13)$$

where *V:VO* and *A:1* are read with only the main-winding circuit energized, and *A:J1* and *A:J2* are read with both windings energized if the pulsating torque on combined-winding operation is desired. If pulsating torque with main winding only energized is desired, it is necessary to read only the first two quantities for then,

$$(A{:}1) = (A{:}J1) = (A{:}J2) \text{ and}$$
$$T_p = (V{:}VO)(A{:}J1) = E_a I_1 / K \qquad (14)$$

Locus of the air-gap flux, often important to the designer, is found readily by reading E_f and E_b. If the space position is desired, it is necessary to read these two voltages in vector form.

Servo motor performance calculations are readily made. Impressed voltages can be unequal in magnitude and displaced from each other by any time angle.

Motors with double-cage rotors, both polyphase and single phase, can be computed by use of additional circuits 5 and 6, where these represent, respectively, the forward and backward impedances of the bottom cage. Polyphase motors can be calculated for balanced or unbalanced supply voltages. Comparative performance curves of a permanent-split capacitor motor, with single and double cages, were made and plotted in Figure 9, by way of illustration. The double-deck rotor gives less full-load slip and less breakdown torque, just as in a polyphase motor.

Polyphase motors are computed using the circuit of Figure 7, where the forward and backward networks represent the positive- and negative-sequence networks. Usually the impressed voltages are balanced and the backward network can be simply short-circuited by throwing the winding-connection switch *SC* to the bottom position.

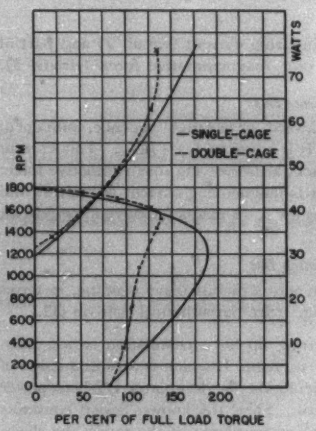


Figure 9. Speed-torque and power-input curves for a permanent - split capacitor motor with single-cage and double-cage rotors compared, as computed by the calculator

Saturation effects can be taken into account if the reactance is known as a function of current. The circuit is set up in the usual manner, using a nominal value of reactance, which is reset to the correct value after an initial reading of current. Occasionally a second or third setting may be necessary.

Speed control of permanent-split capacitor motors is sometimes effected by use of an adjustable external impedance. For this purpose, circuit 5 or 6 can be connected in series with circuit 1. In fact, spare circuits 5 and 6 have proved useful for a number of other purposes.

It is obvious that many other circuits can be set up, to represent other machines or other conditions. The possibilities are almost unlimited.

Experience has amply demonstrated the invaluable assistance of MONECA as a teaching aid in giving the student engineer a better and clearer grasp of fundamental motor theory.

SUMMARY AND CONCLUSIONS

An analogue-type computer has been developed with a number of novel and useful features:

Flexibility. All circuits are brought out to a common panel, permitting an almost unlimited number of possible circuits that can be used.

One Set of Meters. All readings are taken with the same set of meters. This minimizes as much as possible instrument errors. Meters are electronic, with practically negligible drain from the circuit being metered.

Convenient Panel for Recording Readings. This is a sliding leaf which pulls out of instrument at operator's right.

Schematic Circuit in Front of Operator. This is on the sloping surface in full sight of the operator. It is under a Plexiglas panel, which is readily removable, making it easy to insert the schematic diagram of the circuit for which the calculator happens to be wired at the time of use.

Circuit Selector Switches. Circuit selector switches are conveniently located between the schematic diagram and the meters. They select the circuit to be metered.

Easy for a New Operator to Learn. The features just mentioned make it easy for a beginner to learn to operate the board, and also make it easier for him to grasp the significance of the various instrument readings.

Instrument Control Switches. These switches are conveniently located just to the left of the meters, where they are easily controlled by the operator's left hand. These control the scales and functions of various meters.

Operator Can Sit for Most Calculations. Most-used controls are located so they can be reached by operator without moving from his chair. Entire sets of performance curves on any one motor can be performed at one sitting. Only exception is the controls for magnetizing reactances; these are located at the top of the board, in the least accessible place, as they are least often changed in the course of calculations on a given motor. However, the iron-loss potentiometer resistances are located on the lower left-hand panel of the board, where they are easily reached by the operator who adjusts them while looking at the wattmeter. Most often used are the controls for the rotor circuits, also for the generators; these controls were, therefore, put on the lower rows of panels.

Calculator Is Fast. The calculator is two to ten times as fast, or even more, as longhand calculations. The more complex the calculation, the more time is saved, because MONECA solves complicated circuits as fast as simple circuits, and that is virtually instantaneously. Its principal value is for making combined-winding calculations on single-phase motors.

Effects of Changes of One or More Variables Can Be Instantly Noted. This permits the making of investigations often much faster than can be done by testing and often more accurately, because it is difficult to adjust only one factor at a time in a motor—there are so many variables in the building of a motor. Much testing and sample-building time can be saved as well as design time. The amount of time which is saved thereby is considerable, though the amount of time thus saved is difficult to approximate.

Two Blank Panels. These were allowed to provide for possible future expansion of the calculator for purposes not anticipated in the original model.

Can Be Plugged Into a Lighting Circuit. No motor-generator sets or rotating apparatus is required.

MONECA is thus a powerful new tool designed for motor engineers. It reduces the time required for many calculations now made manually, and makes it feasible and practicable to make many needed calculations not now made because of the time required. It multiplies the output of the design engineer and reduces the number of samples that have to be built and tested to achieve a given result. The number of future uses to which it could be put appears to be almost unlimited.

SYMBOLS

E = line volts
E_{bs} = voltage induced in auxiliary winding by its own backward field
E_{bm} = voltage induced in main winding by its own backward field
E_{fs} = voltage induced in auxiliary winding by its own forward field
E_{fm} = voltage induced in main winding by its own forward field
I_1 = primary current
I_{1s} = auxiliary winding current
I_{1m} = main winding current
I_2 = secondary current, referred to primary
I_{2b} = secondary current, backward field, referred to primary
I_{2f} = secondary current, forward field, referred to primary
i_m = magnetizing current
i_{mb} = magnetizing current to set up backward field
i_{mf} = magnetizing current to set up forward field
K = $\frac{\text{effective conductors in auxiliary winding}}{\text{effective conductors in main winding}}$
R_b = apparent rotor resistance to backward field, referred to main winding
R_f = apparent rotor resistance to forward field, referred to main winding
r_1 = primary resistance, polyphase motor
r_{1s} = auxiliary-winding resistance
r_{1m} = main-winding resistance
r_2 = rotor resistance
polyphase motors referred to primary winding
single-phase motors, referred to main winding
r_f = resistor simulating fron loss
s = slip, as a fraction of synchronous speed
T_p = maximum value of double-frequency torque in synchronous watts
V_s = vars input to main winding
V_m = vars input to main winding
W_s = watts input to auxiliary winding
W_m = watts input to main winding
X_b = apparent rotor reactance to backward field, referred to main winding
X_f = apparent rotor reactance to forward field, referred to main winding
x_1 = primary leakage reactance, polyphase motor
x_{1s} = primary leakage reactance, auxiliary winding
x_{1m} = primary leakage reactance, main winding
x_2 = secondary leakage reactance, referred to main winding
Z_b = apparent rotor impedance to backward field, referred to main winding
Z_f = apparent rotor impedance to forward field, referred to main winding

REFERENCE

1. The Revolving-Field Theory of the Capacitor Motor, W. J. Morrill. AIEE *Transactions*, volume 48, April 1929, pages 614-29.

Vector Potential Derivation From Scalar Potentials

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MEMBER AIEE

THE AUTHOR recently published Tables of Green's Functions[1] for the solution of partial differential equations in rectangular co-ordinates. The Green's Functions, as given in those tables, include only scalar potentials. However, in dealing with the fields due to currents or permanent magnets, vector potentials usually are used. These vector potentials also can be derived from the Tables of Green's Functions as is shown here.

The vector potential can be defined in three ways.

1. In the American Standard Definition of Electrical Terms it is stated: "A vector potential field of a tubular vector field is a vector field which has the property that its curl is the tubular vector field."[2]

2. The second definition is based upon Lorentz's solution of Maxwell's equation which gives the vector potential **A** as $\mathbf{A}=\int\int\int[\rho\mu]dx_1dy_1dz_1/R$.

3. A third definition may be taken as follows. "The vector potential **A** at a point may be defined as follows in rectangular co-ordinates. From the point x, y, z draw a line to infinity in the direction of one of the axes. Then the total flux in the direction of one of the other axes crossing the line between the point and infinity may be taken as μ times the component of vector potential in the direction of the third axis at the point. Since there are two such axes this gives two components of vector potential. The third component of vector potential in the direction of the first line drawn to infinity is zero. In the above μ is the permeability of the medium."

It can be shown that when there is no variation with time the components of vector potential are the work done in bringing up along one of the axes from infinity to the point a unit current in unit length of wire oriented successively in the direction of each of the axes. When the currents are brought up along the y axis it is found

$$A_x=-\frac{1}{\mu}\int_\infty^y B_z dy,\quad A_y=0,\quad A_z=\frac{1}{\mu}\int_\infty^y B_x dy \tag{1}$$

When the currents in unit length of wire are brought up along the other axes different expressions are obtained but they give the same values of **B**, showing the definition of vector potential is not unique. It can be shown that **B** also can be derived from a scalar potential V where

$$V_1=-\frac{1}{\mu}\int_\infty^x B_x dx,\quad V_2=-\frac{1}{\mu}\int_\infty^y B_y dy,\quad V_3=-\frac{1}{\mu}\int_\infty^z B_z dz \tag{2}$$

Combining these with equation 1 and knowing that V_1, V_2, V_3 only differ by a constant

$$A_x=\int_\infty^y\frac{\partial V}{\partial z}dy,\quad A_y=0,\quad A_z=-\int_\infty^y\frac{\partial V}{\partial x}dy \tag{3}$$

These formulas can be applied directly to the results in the Tables of Green's Functions to obtain expression for vector potentials from the scalar potentials given there In the original article the following fields are derived.

1. The scalar and vector potential due to a point source.

2. The scalar and vector potential due to a thin rectangular sheet of magnetic material or a rectangular coil. This is worked out in two ways using definitions 2 and 3.

3. The scalar and vector potential due to a circular coil.

4. The scalar and vector potential due to an infinite wire equation 1 when it has a static charge on it and equation 2 when it has a current in it.

Here results obtained for example 2 are shown.

A thin sheet of magnetic material in the yz plane is bounded by the lines $y=a$, $y=-a$, $z=b$, $z=-b$. It is magnetized uniformly in the x direction. Find the scalar and vector potentials.

From the Tables of Green's Functions it is found that for a point charge or pole in free space the potential is given by

$$V=\frac{1}{\pi^3}\int_0^\infty d\alpha\int_0^\infty d\beta\int_0^\infty d\gamma\cos\alpha(x-x_1)\cos\beta(y-y_1)\cos\gamma(z-z_1)/(\alpha^2+\beta^2+\gamma^2) \tag{4}$$

The thin magnetic plate can be regarded as made up of numbers of magnetic doublets whose potential is given by $V_1=\partial V/\partial x$ and which extend from $y=a$ to $y=-a$ and from $z=b$ to $z=-b$. Thus the potential V_2 due to the thin magnetic plate is

$$V_2=\int_{-a}^{a}dy_1\int_{-b}^{b}dz_1\frac{\partial V}{\partial x}$$
$$=-\frac{1}{\pi^3}\int_{-a}^{a}dy_1\int_{-b}^{b}dz_1\int_0^\infty d\alpha\int_0^\infty d\beta\int_0^\infty\alpha d\gamma\sin\alpha(x-x_1)\cos\beta(y-y_1)\cos\gamma(z-z_1)/(\alpha^2+\beta^2+\gamma^2) \tag{5}$$

From the scalar potential V_2 the vector potential is obtained from equation 3. From the known theorem that the current in any circuit produces the same field as the equivalent magnetic shell, this expression then gives the field due to a current in the circuit which coincides with the boundary of the above thin sheet of magnetic material when multiplied by an appropriate constant.

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Digest of paper 52-129, "The Derivation of Vector Potential From Tables for Scalar Potential," recommended by the AIEE Committee on Basic Sciences and approved by the AIEE Technical Program Committee for presentation at the AIEE North Eastern District Meeting, Binghamton, N. Y., April 30-May 2, 1952. Scheduled for publication in AIEE *Transactions*, volume 71, 1952.

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Operating Synchronous Condensers on the Southern California Edison Company System

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A description of the operation of this system with 1,331 megavolt-amperes of synchronous condensers is presented. Oscillograms of two unrelated cases of instability are discussed.

THE SOUTHERN California Edison Company has an extensive 220-kv transmission system consisting of 1,765 circuit miles located in central California, southern California, and southern Nevada. The company has installed 1,331 megavolt-amperes of synchronous condenser capacity to control transmission system voltage as well as partially to supply the 3/4 megavar required for each megawatt of peak system load.

Figure 1 illustrates the Y-shaped transmission system. Big Creek and Hoover hydroelectric plants are located at the extremities of the Y, approximately 260 miles from the load center. The steam capacity representing 49 per cent of the total system kilowatt resources is located close to the load center, near the junction of the arms of the Y.

The 14 66-kv subtransmission systems are normally interconnected only through the 220-kv network. Each 66-kv system is provided with synchronous condensers for reactive supply and voltage control. All of the 220/66-kv transformer banks purchased since 1929, except two required to parallel with existing banks, are equipped with load ratio control. The transformer banks have been so located, that 11 of the 220/66-kv substations have load ratio control.

The condensers located at the fixed tap substations are used to maintain 66-kv voltage schedules which provide for increased bus voltage during the heavy load period to compensate for regulation in the subtransmission system. The condensers located at the substations equipped with load ratio control are used not only to maintain required 66-kv voltage schedule, but also directly as a source of vars to control 220-kv system voltage levels. The kilovars required to stabilize 220-kv voltages may not correlate with the 66-kv bus voltage schedules as the reactive demand of the 220-kv system is largely determined by the amount of hydroelectric generation at the Big Creek and Hoover plants. It is necessary to control 220-kv voltage on the Edison system to avoid undesirable var transfer over the two large interconnections with adjacent utilities. Control of transmission system voltage is also required for efficient system operation and maintenance of 66-kv bus voltage on the company's own system. To accomplish stabilization of 220-kv voltages, voltage control centers have been established at the Big Creek and Hoover hydroelectric plants, and a major substation at the southern load center.

Outages of long transmission lines produce increased reactive demands. If adequate steady-state stability margins are to be maintained, it is important that 66-kv busses be returned to their normal voltages as rapidly as possible. The response of a synchronous condenser to a sudden change in system voltage is always corrective, while the response of a static capacitor is always wrong. In subtransmission areas where large numbers of static capacitors are installed, it is very desirable after the loss of long transmission line to maintain normal voltages to prevent the static capacitor kilovar correction from falling off as the square of the voltage.

The 220-kv lines, originating at the company's hydroelectric plants, start out at approximately surge impedance loading at peak load periods. Since at most periods of the year these plants are used for peaking, there is a large daily change in bulk transmission system reactive demand, which exceeds 300,000 kilovars at times.

There are three installations of the out-of-step type of automatic separation on the 220-kv system, which provide for dividing the system into two, three, or four separate load areas, each with a block of load and sufficient generation to carry the load. The four separated load areas are: 1. The Big Creek load area. 2. The Edison Hoover load area. 3. The Metropolitan Water District Hoover system. 4. The steam load area.

As shown in Figure 1, the arrangement of the system

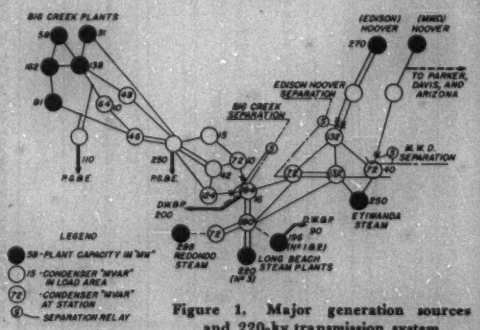

Figure 1. Major generation sources and 220-kv transmission system

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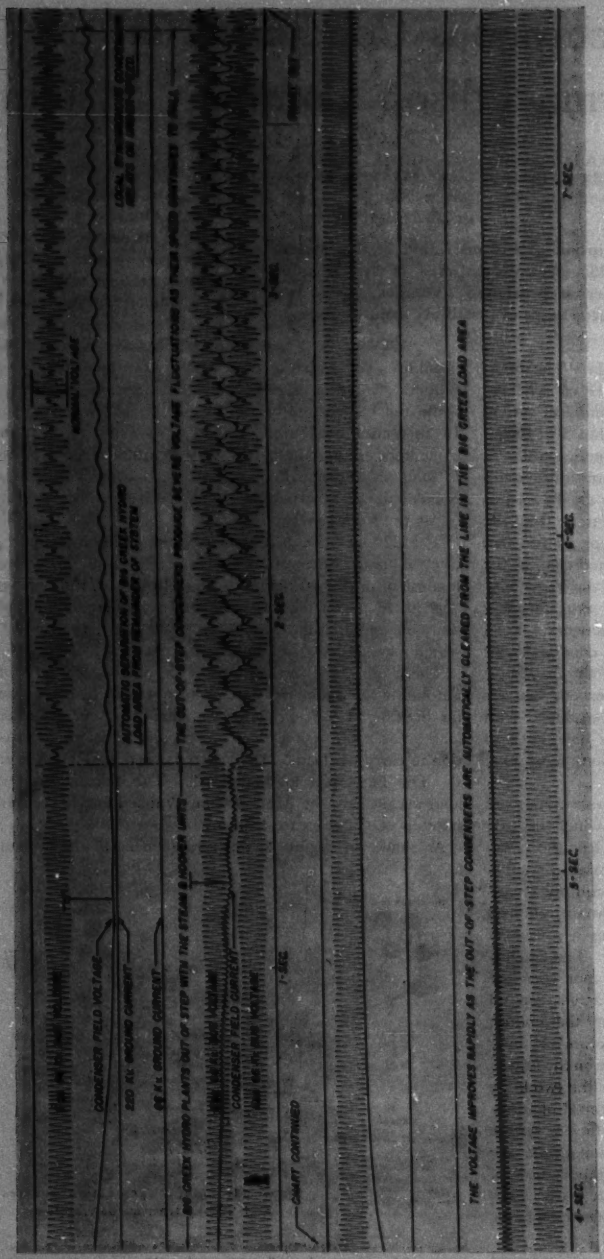
CONDENSER FIELD VOLTAGE
220 KV. GROUND CURRENT
66 KV. GROUND CURRENT
BIG CREEK HYDRO PLANTS OUT OF STEP WITH THE STEAM & HOOVER UNITS
CONDENSER FIELD CURRENT
CHART CONTINUED
1 SEC.
2 SEC.
3 SEC.
4 SEC.
5 SEC.
6 SEC.
7 SEC.
THE VOLTAGE IMPROVES RAPIDLY AS THE OUT-OF-STEP CONDENSERS ARE AUTOMATICALLY CLEARED FROM THE LINE IN THE BIG CREEK LOAD AREA

Figure 2. Oscillogram of an out-of-step disturbance recorded at a 220/66-kv substation of the Southern California Edison Company

is such that local out-of-step voltages and currents at the separation points can be utilized for operating the out-of-step relays and tripping the necessary circuit breakers to perform a Big Creek or a Metropolitan Water District separation. The Edison Hoover separation is somewhat more complicated in that an out-of-step condition at one station is detected by the automatic separation relay which, in turn, trips preselected circuit breakers at three other stations via 220-kv power-line frequency-shift carrier channels.[1]

The Big Creek and Edison Hoover separation relays are of the "1-slip cycle" type,[3] whereas the Metropolitan Water District separation relays are of the older type[4] which require from five to six slip cycles to operate.

In practically every case of instability requiring a separation of the 220-kv system, the hydroelectric generators overspeed in one or more load areas, while the steam generators maintain normal or slightly subnormal speed. Experience has shown that when the generators in a hydroelectric area overspeed and go out-of-step with the remainder of the system, most or all of the synchronous condensers in that load area follow the speed of the steam generators until the automatic separation is performed. Immediately following separation, the hydroelectric generators are above normal speed, whereas most of the condensers in the load area are at approximately normal speed and out-of-step with the generators. These condensers do not resynchronize, but instead, slow down and reach a state of equilibrium at a speed approximately 70 per cent of the generator speed.[4] The out-of-step condensers subject the separated load area to severe voltage fluctuations.

To terminate the voltage dips associated with an out-of-step condenser, the company has installed underspeed trip devices of the mechanical type connected to the condenser shaft, or a frequency relay actuated by a small shaft-driven generator. These underspeed devices are set to relay the condenser at about 56 or 57 cycles.

Oscillograms shown in Figures 2 and 3 illustrate the sequence of operations in two unrelated cases of instability. These records were made at a 220/66-kv substation at the southern end of the

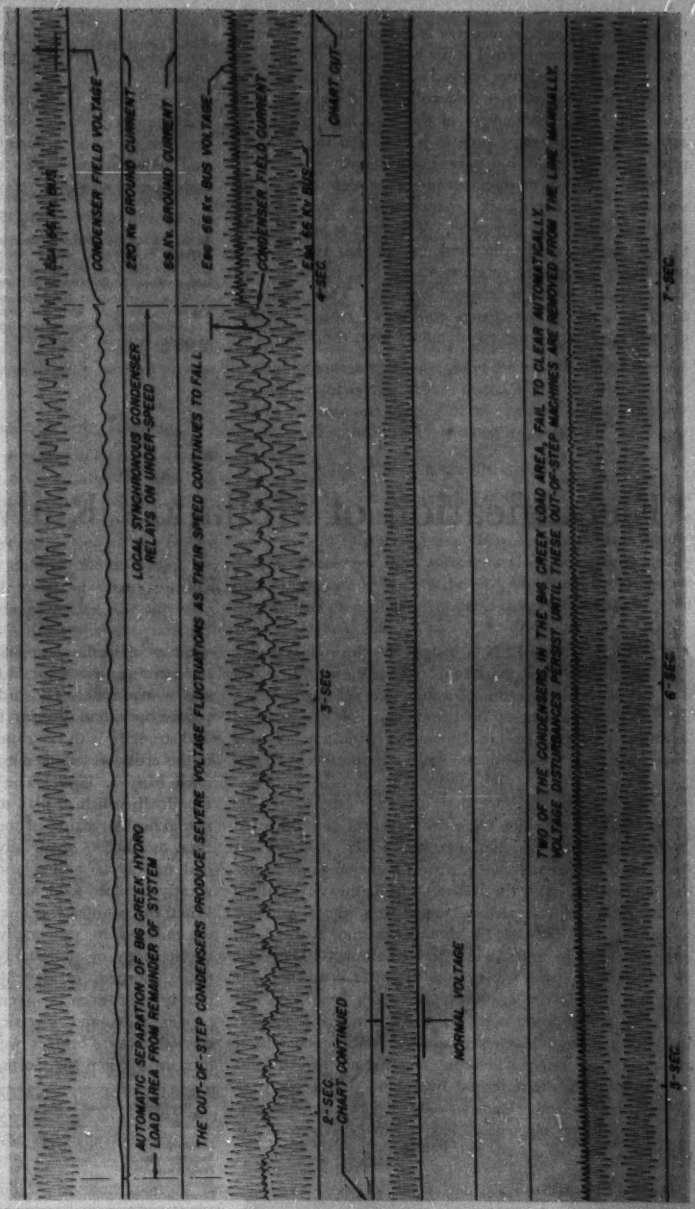
CONDENSER FIELD VOLTAGE
220 Kv GROUND CURRENT
66 Kv GROUND CURRENT
66 Kv BUS VOLTAGE
CONDENSER FIELD CURRENT
66 KV BUS
CHART CUT
4-SEC
3-SEC
2-SEC
CHART CONTINUED
NORMAL VOLTAGE
3-SEC
6-SEC
7-SEC
AUTOMATIC SEPARATION OF BIG CREEK HYDRO LOAD AREA FROM REMAINDER OF SYSTEM
LOCAL SYNCHRONOUS CONDENSER RELAYS ON UNDER-SPEED
THE OUT-OF-STEP CONDENSERS PRODUCE SEVERE VOLTAGE FLUCTUATIONS AS THEIR SPEED CONTINUES TO FALL
TWO OF THE CONDENSERS IN THE BIG CREEK LOAD AREA FAIL TO CLEAR AUTOMATICALLY. VOLTAGE DISTURBANCES PERSIST UNTIL THESE OUT-OF-STEP MACHINES ARE REMOVED FROM THE LINE MANUALLY.

Figure 3. Oscillogram of an out-of-step disturbance recorded at a 220/66-kv substation of the Southern California Edison Company

Big Creek load area, close to the Big Creek separation point, but approximately 250 miles from the Big Creek generating plants. This substation has one 72,000-kva synchronous condenser which is connected to the 66-kv bus through a separate transformer bank. This condenser is equipped with a rotating-type voltage regulator.

In 1950 and 1951, when these Big Creek separations were made, the automatic separation equipment was of the older type consisting of three instantaneous contactor-type overcurrent relays, a notching or ratchet relay, an auxiliary tripping relay, and a plug board for selecting the desired circuit breaker trip circuits.

In the oscillogram shown in Figure 2, the instant that the separation occurred is marked by a small spike of 220-kv ground current which resulted from the opening of 220-kv circuit breakers. The separation occurred during the fifth slip cycle as the Big Creek generator speed increased. The notching relay evidently retrieved after each of the first two (relatively slow) slip cycles, and then notched up to the closing position on the impulses from the following three slip cycles as the impulses increased in frequency.

The frequency of the voltage recorded at this substation prior to separation is that of the steam system. After separation, the recorded voltage is governed by conditions in the Big Creek load area, and the out-of-step surges are produced by condensers which are out-of-step with the Big Creek generators. Following the Big Creek separation, the voltage record of Figure 2 shows that the speed of the condensers dropped

rapidly, and no sign of recovery is indicated. In addition to a return to near normal 66-kv bus voltage, the point at which the local condenser relayed is shown by an additional transient in the condenser field voltage and current. The other out-of-step condensers in the load area tripped at approximately the same time as is indicated by the rapid recovery of the 66-kv bus to normal voltage.

Figure 3 shows an oscillogram of another case of instability. The Big Creek separation took place during the sixth out-of-step slip cycle. This case is very similar to the one previously discussed, except that two remote, out-of-step condensers, totalling 40,000 kva, failed to clear automatically with underspeed devices. This relatively small amount of out-of-step equipment caused voltage disturbances until removed manually from the line. The duration of the disturbance was 20 seconds, and was terminated by prompt action on the part of a substation operator.

For 20 years, the Southern California Edison Company has followed a practice of terminating out-of-step conditions between generator groups by automatic system separation; and between out-of-step condensers and the system by condenser low-speed relays.

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Electrification of Holland's Railway System

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THERE HAS BEEN a galaxy of dissimilar trolley electrifications scattered throughout the world, nearly all of them successful in a way, but reflecting a lack of co-ordination among the proponents of this type of propulsion. Once having chosen a system, a railroad sometimes finds it expensive to change to another.

THE NETHERLANDS RAILWAYS

ONE RAILROAD which chose its system of electrification more than 25 years ago and which has had an opportunity in recent years to review and change its earlier decision, if desired, is the Netherlands Railways. Trolley electrification of this railroad dates from the year 1908 when the line between Scheveningen and Rotterdam, approximately 15 miles, was operated from a 10,000-volt a-c 25-cycle overhead trolley line. In 1924 it was decided that a change to the 1,500-volt d-c system would reduce overhead line troubles and also traction motor problems. By 1927 the original electrification had been converted and electrical services had been extended northward from Rotterdam to Amsterdam and Ijmuiden. Up to the year 1940, when the Netherlands was invaded by the Germans, the network of electrified lines had been expanded gradually.

WAR DAMAGE AND RECOVERY

No industry in the Netherlands suffered as much war damage as did the railway system. When British paratroopers were dropped on the north side of the Rhine near Arnhem on September 17, 1944, a command was broadcast from the Dutch government in exile for the railroad workers of Holland to quit work and go into hiding, to hamper the movement of German troops and supplies in this whole area. The order was obeyed, but the 8,000 paratroopers had dropped into unsuspected German armor and strength, with the result that the advance of the Allies in this area was stemmed and the Netherlands was not freed until May 5, 1945. The Germans, then, had nearly 8 months in which to plan and carry out a vindicative and methodical wrecking of the railway system, during which time the 30,000 loyal railway workers and their families had to stay in hiding and the whole populace suffered greatly because food and fuel could not be transported. When the country was finally freed, there was little left of the railways, for practically everything had been removed to Germany or thoroughly wrecked. Rolling stock was taken, burned, or destroyed; shops were looted completely—not even a wrench or screw driver was left; copper wire and electric substation equipments were carried away; bridges were wrecked; and tracks were torn up. When the Germans capitulated, the status was:

Per Cent Destroyed or Stolen		Per Cent Destroyed	
Locomotives	84	Stations	18
Passenger cars	94	Signal towers	68
Freight cars	98	Railbed	62
Electric trains	99	Bridges	70
Diesel-electric trains	100		

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The railways of the Netherlands were almost totally destroyed at the close of World War II. After carefully considering other systems, the earlier decision to electrify with the 1,500-volt d-c system was reaffirmed. Holland now has one of the most progressive railways in Europe.

Seven years later, by June 1952, the Netherlands Railways was again a smoothly operating, progressive railroad, with an "on-time" record that would be the envy of any American railroad. Trolley-electric motorcars and streamlined trains have been recovered from Germany and rehabilitated or have been salvaged from the wreckage left in the country; diesel-electric motorcars and trains have been recovered and put into operating condition again; steam locomotives have been returned or used ones bought from the Allied Army surplus; trolley-electric locomotives have been purchased or rented; bridges have been repaired; signal equipment reconditioned; stations rebuilt; and many other very surprising reconstructions have been accomplished.

RESELECTION OF THE 1,500-VOLT D-C SYSTEM

After the destruction of the railroads by the Germans in 1944–45, an excellent opportunity was afforded to start all over with a different power supply system if desired. A thorough study, however, confirmed the earlier decision to use 1,500-volt d-c power for the trolley lines, this being based on the density of the traffic, the prevalence of large cities and towns in relatively close proximity, and the previously demonstrated low operating costs of the 1,500-volt system. Moreover, such a medium-voltage d-c system makes the operation of trolley electric-motorcar trains very practical at a nominal cost for equipment and repairs. Because of the predominance of these trains in the Netherlands, this factor was of considerable weight.

Since economy is of importance in the electrification of any railroad, the selection of a system involves some definite objectives:

1. To convert from commercial power systems to a type of electric energy suitable for distribution to moving vehicles, using the simplest equipment and with the maximum efficiency.
2. To minimize the first cost of the distribution structure and equipment. The use of a voltage as high as practicable to minimize the amount of copper needed and to require the fewest number of substations assists in keeping installation costs low.
3. To minimize the cost of parasitic distribution equipment.
4. To use equipment both in the distribution system and on the vehicles which will have the lowest possible maintenance costs, because such costs are continuing over the years. Low repair costs also reflect a high degree of reliability.

The 1,500-volt d-c distribution, as decided upon by the Netherlands Railways, encompasses all of the features of an ideal system with the exception that the overhead trolley construction is somewhat heavier than might be desired and the substation spacing is not as great as for higher voltage systems. These objections were accepted, however, in order to obtain the other indisputable advantages which, for the concentrated traffic found on this railroad, far outweigh the objections. The rectifiers used to convert from the 3-phase 50-cycle commercial power system to 1,500-volt direct current are simple, reliable, and efficient; there are no parasitic devices necessary, such as are often used with a-c systems to reduce inductive disturbances; and the substation equipment, the traction motors, and the control devices of the rolling stock long have been proved reliable and of low maintenance costs. Actually, the structures supporting the overhead wires are very little, if any, more expensive than for a high-voltage system, and the weight of the wires is not excessively greater, so that the prime increase in distribution costs lies in the reduced spacing of substations. However, once installed, this factor is of reduced importance.

THE NETHERLANDS

In general, the Netherlands is flat and few important grades are encountered. See Figure 1. In the western and northern parts, there is considerable polder land. These are areas surrounded by dikes and usually lying below sea level. In the east, the ground is somewhat higher and is rolling. In the southeast, such as in that

Figure 1. Map of the Netherlands

neck which protrudes southward between Germany and Belgium from Roermond to Maastricht and Heerlen, there are pronounced ridges and valleys. The lowest elevation of the country is approximately 20 feet below sea level and the highest point is in the extreme southeast near Heerlen where there is an elevation of 321 meters or 1,050 feet. Sand is encountered almost everywhere and clay is common. The principal cities lie in the western part of the country, but Holland is actually an industrial nation and practically every town has its shops and factories.

TRAFFIC

INTERNAL COMMERCE of the Netherlands depends upon three basic transport systems: the railroad, the waterways, and the highways. The railroad has far from a monopoly in the transport of freight because of a national system of canals. Since a large part of the country is built on the deltas of the Rhine, the Maas (Meuse), and the Sheldt, and since these rivers divide and subdivide into a large number of natural and artificial waterways, it followed that the early inland commerce was mostly waterborne. Add to this the vast system of canals and ditches necessary for the control of water levels throughout those areas reclaimed from the seas which could be expanded easily into further commercial waterways, and the result is a pattern of water routes that extends even to the remote and elevated portions of the country. Actually there are about 4,800 miles of such navigable waterways, nearly $2^1/_2$ times the railway mileage, some for small barges but many for larger vessels. About 340 miles of canals are for vessels of 2,500 tons or larger.

The bulk freight of the Netherlands is generally moved by diesel-engine-driven canal barges. Highway vehicles have not as yet become a serious competitor for the railroad or canals. The division of the internal freight traffic is approximately as follows:

	Tons of Freight, Per Cent	Ton-Miles of Freight, Per Cent
By railroad	15	32
By water	39	53
By highway	46	15

The Netherlands Railways does a very brisk passenger business. The railway system handles approximately 160 million passengers per year for 3.9 billion passenger miles and requires 24 million passenger-train miles of operation. At the same time, the train-miles in freight service total about 9.3 million. Passenger services account for approximately 58 per cent of the total revenue and freight service for but 38 per cent, the balance being made up by diverse services such as mail, baggage, and so forth. While American railroads consider passenger services unprofitable, the Netherlands Railways has an operating ratio of around 74 which is extremely favorable.

RAILROAD OPERATION

IT IS EVIDENT that the character of the Netherlands Railways differs from that of the normal American railroad. Emphasis is placed upon passenger-train services, and schedules must be so arranged that little interference is occasioned by the operation of freight trains. Most of these are moved at night and are not on the main lines at the time that the heavy passenger traffic peaks occur. The result of this, and also of the rigid policing of passenger-train delays, is that the railroad has an "on-time" record which should be the envy of nearly any of the railroads of the American continent.

The Netherlands Railways owns and operates a comprehensive network of lines extending to all parts of the country and serving practically every community in the nation. The heaviest traffic is concentrated in the western central part of this area. The Annual Report for the year 1950 showed 1,988 miles of railroad in operation, 1,055 miles of which are of single track and 933 miles of double track. Of these, 507 miles of the double track and 48 miles of the single track are electrified and work has been progressing rapidly in the extension of this system. It is expected that a total of approximately 787 miles will be electrified by the end of 1953. In the end, approximately 42 per cent of the mileage will be trolley electrified, this trackage carrying about 85 per cent of the passenger miles and 80 per cent of the freight-ton miles. The ultimate use of diesel-electric motorcars or locomotives has been planned for all other lines and for switching services, thus retiring all steam motive power.

THE ROADWAY

ALMOST ALL OF the main-line rail is 46 kilograms per meter, or 92.5 pounds per yard, but some heavier rails of 63 kilograms per meter, 127 pounds per yard, are on trial. Rails are of the T-head shape with flat bottoms, those for the main lines being clamped to special tie castings which, in turn, are held in place on treated ties by screw fastenings. For yards and sidings, the rails are set on tie plates and spiked down. Rail joints are set opposite each other, generally located between ties, which is contrary to the general American practice of staggering the rail joints. Each of the cast tie plates is finished for a 1:20 inward cant of the rail. Rails are laid on treated ties and ballast is generally of gravel since cut stone is relatively expensive. In view of the unstable character of the soil under the roadbed, the railroad's engineers try to limit the weight per axle to 16 metric tons, around 35,000 pounds. Tracks are spaced 13 feet apart where practicable.

MOTIVE POWER

AS OF JANUARY 1, 1951, the Netherlands Railways owned:

744 steam locomotives
15 trolley-electric locomotives
51 diesel-electric locomotives
4 diesel-mechanical locomotives
148 diesel-electric "locomotors"*
10 heater cars
109 individual trolley-electric motorcars
567 trolley-electric bodies for 2-, 3-, 4-, and 5-car trains
157 diesel-electric bodies for 3- and 5-car trains

* A "locomotor" is a small switching locomotive operated by one man, who need not be a trained engineman.

This inventory has been augmented in 1951 and 1952 by the addition of Alsthom 2,950-horsepower, 4-axle, and of 3,800-horsepower 6-axle trolley-electric locomotives, and some 6-axle Heemaf locomotives. When these orders are completed the railroad will have 95 trolley-electric locomotives. The number of streamlined trolley-electric trains is also being gradually increased and some additional diesel-electric motor trains are being received also.

STEAM LOCOMOTIVES

THE STEAM LOCOMOTIVES are heterogeneous in type, ranging from relatively small switchers to Consolidations, 2–8–0, and 10-wheelers, 4–6–0. There are also a few heavier locomotives, used for such purposes as humping, and some 4-cylinder locomotives. Present plans call for the abandonment of all steam locomotive operations in the Netherlands as rapidly as possible.

TROLLEY-ELECTRIC LOCOMOTIVES

WITH THE COMPLETION OF the trolley-electric locomotives now on order, the Netherlands Railways locomotive inventory will be

Design	Oerlikon	Alsthom**	Heemaf†	Alsthom
Number of locomotives	10	50	25	10
Number series	1000	1100	1200	1300
Wheel grouping	1A-Bo-A1	Bo+Bo	Co-Co	Co-Co
Total weight, tons	100	80	120	110
Adhesive weight, tons	72	80	120	110
Maximum miles per hour	100	75	87	75
Horsepower, continuous*	3,890	2,540	3,000	3,800
Miles per hour at continuous horsepower*	67	50	45	50
Wheel diameter, inches	61	49.3	43.4	49.3
Rigid wheelbase, feet and inches	7 3½	11 8	15 6	15 11

* At 1,350 line voltage. ** Figure 2. † Figure 3.

These locomotives are used for both passenger and freight work and do not leave the country because the German railways to the east are not electrified and the Belgian railroads to the south use 3,000 volts direct current.

TROLLEY-ELECTRIC MOTORCARS AND TRAINS

MOST OF THE PASSENGER TRAFFIC is served by multiple-unit streamlined trains, groups of cars being permanently coupled to form train sets, Figure 4, and provided with automatic tight lock couplers at each end of each train set so that they may be operated in multiple. Passengers may circulate freely between cars of any train set, but there is no passage through the rounded ends of coupled sets. Any 2-, 3-, 4-, or 5-body set may be coupled and operated in multiple with any other set. These train sets are provided with second- and third-class accommodations, baggage compartments, toilets, and in some cases with a buffet. There are also 34 streamlined postal cars, with a rounded nose at each end, arranged for coupling between or behind trolley-electric train sets as needed. These postal cars are not motored.

Before the war the Netherlands Railways had 275 bodies for these trains. By 1951 approximately 220 of these had been recovered and rehabilitated. Others are being build, and by the end of 1952 it is expected that the trolley-electric streamlined train inventory will be as follows:

99	2-body train sets	198 car bodies
33	3-body train sets	99 car bodies
90	4-body train sets	360 car bodies
19	5-body train sets	95 car bodies
241	streamlined train sets	752 car bodies

In addition, there are 101 old individual multiple-unit motorcars and 131 trailers not of streamlined construction which are still in use.

The trolley-electric motorcars have been purchased at intervals and there are some marked variations in construction. The two basic types, of course, are the non-streamlined individual units, 1927, and the more modern streamlined trains of permanently coupled units adopted as standard in 1934. Although all of the latter are of the same general design, consisting of 2, 3, 4, or 5 permanently coupled car bodies having an ellipsoid nose at each end of each train set, the trucks, body constructions, and equipment have varied from time to time with the acquisition of additional train sets. The control systems of all of these cars embody bridging-type main circuit connections and automatic acceleration. Starting tractive forces are limited to give no more than 10 per cent adhesive factor between the wheels and rails so that it is not necessary to

Figure 2. Alsthom Bo-Bo trolley - electric locomotive

Figure 3. Heemaf Co-Co trolley - electric locomotive

Figure 4. Four-car MU trolley - electric train set

carry sand on the cars. The 2-car and 3-car train sets have one control equipment and four motors, while 4-car and 5-car sets use two equipments and eight motors. See Figure 5.

DIESEL-ENGINED MOTORCARS

The Netherlands Railways have recovered and rehabilitated but three of their single, mechanical-drive diesel cars, 17 of their 3-body diesel-electric streamlined train sets, Figure 6, and 12 of their 5-body sets. Two additional 5-body sets have been acquired since the war. They also have on order 40 new 2-body train sets and 20 single-car multiple-unit diesel-electric cars. The latter will have the engines mounted under the car floors, whereas the engines of the earlier streamlined train sets had the engines mounted in a walled-off compartment of one of the car bodies. It is expected that the diesel-engined passenger motorcar inventory at the end of 1952 will be

3 single cars, mechanical drive
20 single cars, electric drive, underfloor engines
40 2-body diesel-electric train sets, underfloor engines
17 3-body diesel-electric train sets
14 5-body diesel-electric train sets

The 3-body units are powered by two 400-horsepower, gross, engines and the 5-body trains by three 650-horsepower, gross, plants. All of the trains are arranged for multiple operation with any other diesel-electric trains. The trains on order will have 6 horsepower per ton of train weight.

DIESEL-ENGINED LOCOMOTIVES

The Netherlands Railways use diesel and diesel-electric locomotives for switching purposes, and they also have a large number of diesel-electric locomotors scattered over the system for handling local switching work. These locomotors are of 23 tons weight (United States 2,000-pound tons) on two axles, each driven by an electric motor. Any local employee can operate locomotors and trained enginemen are seldom used. By doing the local and industrial switching with one, or at the most two, unskilled employees, the railroad has accomplished tremendous savings.

The inventory of diesel and diesel-electric switching units now owned or on order is

4 diesel locomotives, mechanical drive
50 English electric diesel-electric switchers, C
18 Whitcomb "war surplus" diesel-electric switchers Bo-Bo
15 miscellaneous diesel-electric switchers
163 locomotors, Bo

MISCELLANEOUS ROLLING STOCK

To complete the rolling stock picture, the railroad owns nearly 25,000 freight cars of various types, most of these being of 2-axle construction with roller bearings and clasp brakes predominating on the later rolling stock. The inventory consists of box cars for fruits and vegetables, refrigerator cars, gondolas, container cars, and many other types as found on any railroad for normal or special purposes. The conventional European couplers are used with side buffers, the face of the right-hand buffer being convex and that of the left-hand buffer being flat.

The railroad owns nearly 700 passenger cars for locomotive-hauled trains. There are also 53 postal cars, 701 baggage cars (including high-speed freight cars), and 13 combination postal-baggage cars for such trains.

There are no signal lines through the trains. Signal for the departure, then, is given by the station master.

TROLLEY-ELECTRIC POWER SUPPLY

Power for the operation of trolley-electric locomotives and multiple-unit trains is generated by the provincial and municipal coal-burning power companies within the Netherlands. Three-phase 50-cycle power is delivered to the railroad substations at 10,000 volts, although some earlier substations are fed at 25,000. Power lines are generally underground and enter the substations in that way. See Figure 7.

Power is converted from 3-phase 50-cycle alternating current to direct current by mercury-arc rectifiers, the sizes in use being 500 kw, 1,000 kw, and 1,200 kw. Stations are built with one or two such units (three or four of the 500-kw size) as the local traffic requires. In all, approximately 119,000 kw in rectifier capacity is now or will be installed by the end of 1952. The normal distance between substations is approximately $12^1/_2$ miles, and there will be a total of 71 substations by that time in addition to which there are three portable substations. Between substations are switching cabins for sectionalizing the lines, both the substations and the switching cabins being remotely controlled.

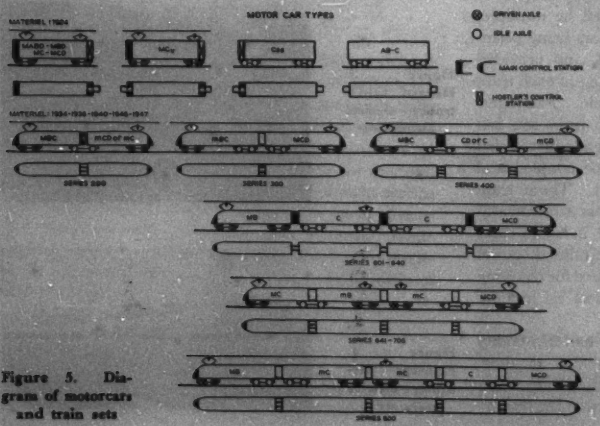


Figure 5. Diagram of motorcars and train sets

Figure 6. Three 3-body diesel - electric train sets

Figure 7. Netherlands Railways substation

SUPPORTING STRUCTURES FOR THE CONTACT WIRES

THE CONTACT SYSTEM of the Netherlands Railways has reached a high degree of practicability and relatively low cost. Starting with single poles and bracket arms on each side of double tracks, the railroad soon learned that poles would cant in the soft ground under wind and ice loads. The solution was to supply a cross member between the pole tops and eliminate the bracket arms. Thereafter there were installations of lattice-type poles, then of vertical "I" beams, then an ogive concrete arch, then vertical cylindrical uprights linked by a horizontal beam. The latter type has become the simple standard system. See Figure 8. Supporting structures were first spaced 75 meters, or 246 feet, apart, later changed to a spacing of 65 meters, or 213 feet, then finally standardized at 70 meters, or 230 feet.

CONTACT SYSTEM

THE STANDARD CONTACT SYSTEM comprises a single copper catenary wire of 150-square-millimeter cross section, around 300,000 circular mils, with hangers from this to two horizontal and parallel contact wires, each with a cross-sectional area of 100 square millimeters (each is approximately equivalent to a 4/0 wire). Paralleling these, mounted on insulators above the supporting cross member, is a single feeder wire with a cross section of 150 square millimeters. The area of the four conductors per track, then, is 500 square millimeters (0.775 square inch or 987,000 circular mils). The contact systems of parallel tracks are tied together to improve the current-carrying capacity. The average height of the contact wires above the surface of the rails is about 5.5 meters or 18 feet 1 inch, with a maximum of 5.85 meters or 19 feet 2 inches, and a minimum of 4.85 meters or 15 feet 10 inches.

Modern practice for double-track lines is to suspend a "Y" structure from the middle of the cross span of the supporting structures with a pulloff from this to the trolley wires, alternating at adjacent supports so that first the right-hand and then the left-hand trolley wires are pulled 35 centimeters, or about $13^{3}/_{4}$ inches, off center, first to one side and then to the other. When one pair of trolley wires is pulled toward the center by the center Y, the other is pulled in the same direction toward the side by a pulloff fastened to the vertical supporting pole. Thus, the trolley wires are staggered a total of 70 centimeters, or $27^{1}/_{2}$ inches. These pulloffs also serve as braces against the strong winds prevalent in Holland. Trolley "pans" are fitted with lead-tin filled graphite bars across a width of 94 centimeters, or 37 inches, so that the contact is always made by these graphite bars.

The trolley wires are sectionalized approximately every 1,500 meters, or 4,921 feet. With these trolley wires anchored in the middle of the section, a tension device, see Figure 9, is provided at each end, exerting a pull of 2,000 kilograms, or 4,410 pounds, or 1,000 kilograms per trolley wire. This tensioning device consists of a pair of pulleys mounted on one of the supporting structures, one pulley being four times the diameter of the other, with a 500-kilogram weight suspended by a cable wrapped over the large pulley. The cable attached to the trolley wires is wound on and anchored to the smaller pulley. This forms a simple and practical tensioning arrangement.

SHOPS AND MAINTENANCE POINTS

THE NETHERLANDS RAILWAYS has four main shops for the overhaul of equipment: Haarlem, in the northwestern area, handles trolley-electric and diesel-electric motorcar overhauls; Tilburg, in the south central part of the country, takes care of locomotives (steam, trolley-electric, and diesel-electric); Amersfoort, just below the Zuider Zee in the central area, handles freight-car repairs; and passenger cars are overhauled at Utrecht, in the central

Figure 8. Double-track overhead contact system

Figure 9. Contact-wire tension device

area. The continuing acquisition of trolley-electric and diesel-electric motorcars and locomotives and the shrinking steam-locomotive inventory has forced changes in shop layouts and equipment and will require still further changes and expansions in the future.

Regular inspections and running repairs of the trolley-electric rolling stock are now made at three points: Amsterdam, in the northwest; Leidschendam, central west; and Maastricht, in the extreme southeast. In general, Amsterdam takes care of trolley-electric motorcars and locomotives; Leidschendam of trolley-electric motor cars; and Maastricht of all types. This, of course, does not cover steam power, whose maintenance points are scattered over the system and are rapidly being reduced in number. Diesel-electric motorcars are inspected at Utrecht, while diesel-electric locomotives are inspected at Rotterdam (Fijenoord), Utrecht, Zwolle, Amsterdam, and Eindhoven.

The Netherlands Railways has a very effective inspection and overhaul program. As an instance of this, trolley-electric motor cars operate in pools; say, 25 4-car trains in Pool G, 13 3-car trains in Pool H, and so forth. Each of these pools takes care of a set of regular runs, each train of the pool operating on a different run each day until all runs have been covered, then starting over again. A marker is placed in the front window to show the pool and the run, such as "H-1." In this schedule of rotation, periodic visits to the inspection sheds are considered as one of the regular assignments. Thus, each of the trains performs exactly the same mileage as the others and is inspected at the same intervals. These trains are withdrawn once a year for light overhaul, once every 3 years for medium overhaul, and once every 10 years for complete rebuilding. Locomotives and diesel-electric motorcars have similar assignments and periodic overhauls.

CONCLUSION

THE DECISION of the Netherlands Railways to retain and to extend the 1,500-volt d-c system of electrification for their lines and services indicates an appreciation of the various factors which have an influence on the economies of this form of power. Thus, they have balanced the low maintenance expenses of medium-voltage d-c motorcar and locomotive equipment against a higher installation cost of the distribution network with close substation spacing (as compared to higher voltage systems), and find a net economy in their favor. In addition, the line troubles are very much lower with 1,500-volt direct current impressed upon the overhead network than if higher voltages, 3,000-volt direct or elevated alternating voltage, were employed. They also have reduced their substation and line costs to their practical essentials. As a result, this railroad stands as one of the best examples of 1,500-volt d-c electrification to be found anywhere in the world.

Radioactive Sodium Used in Locating Leak in Heating System

A spoonful of sodium carbonate made radioactive in Canada's atomic pile was flushed through the radiant heating system beneath 15,000 square feet of concrete floor at the garage of John Labatt Ltd., Toronto, Ontario, Canada, recently to locate a leak in the system.

Isotope Products Ltd., Oakville, Ontario, who used isotope sodium 24 believes that this is the first time in radiant heating that a radioactive tracer technique has been used to solve the problem of locating precisely a break in the hundreds of feet of pipe in the heating system buried beneath concrete floor.

Garage officials at Labatt's had been bothered for some time by knowledge of a leak somewhere in the system, but this could not be localized. It was known theoretically, however, that an isotope tracer could track down the radiant heating break. Sodium 24 was selected for two reasons: its rays could readily penetrate through 6 inches of concrete floor and beyond, and its relatively short half-life of 15 hours meant that it would weaken quickly and would leave the building unconfaminated.

Sodium carbonate was used to dissolve quickly into the water of the heating system for the Labatt job. It was sent to Chalk River, Ontario, where it was "cooked" in the atomic pile; then confined in a lead shipping case and returned to Toronto.

Engineers had constructed a large funnel and connected it to an inlet point of the radiant heating system through an outside wall. The capsule was introduced into the system from this point. A valve was installed beneath the inlet funnel and a 12-foot handle was attached to control the valve from a safe working distance. A long-handled clamp and similar long-handled pike pole were used also. These instruments removed the capsule from the shipping container, pierced the aluminum top of the container to allow the isotope powder to pour into the funnel.

By controlling the funnel valve and by pouring water in from a hose, the engineers regulated the flow of radioactive material into the heating pipes. Geiger and scintillation counters were used to check the operation at every point.

When the diluted isotope had penetrated throughout the system it was flushed clear. The radioactive solution was readily cleared from the pipes and dissolved safely away by a period of flushing. But where the pipe was broken or leaked it left a measure of radioactivity lying in the ground about the leak. With their detection instruments, engineers sought this point.

Systematically following the pipe routes from a blueprint of the garage heating system, they soon found that readings increased towards the southwest corner of the building. As they got closer to the approximate area of the leak they chalked the readings on the cement floor. These numbers soon plotted the location to within a 6-inch square. Here the repair men were instructed to drill through to reach the break.

INSTITUTE ACTIVITIES

Fall General Meeting in New Orleans Will Have Varied Technical and Social Program

Final plans have been made for the variety of technical sessions, entertainment events, and inspection trips scheduled for the 1952 Fall General Meeting to be held in New Orleans, La., October 13–17. Headquarters will be at the Jung Hotel.

The meeting will begin with the general session on Monday morning, to be followed, in the afternoon, by technical sessions sponsored by the Committees on Insulated Conductors, Power Generation, Electronics, and Education. On Tuesday, in addition to a continuation of the sessions on Insulated Conductors and Power Generation, Carrier Current, Instruments and Measurements, and Management will be session topics.

Other technical sessions scheduled for the meeting will include: Wednesday—System Engineering, Industrial Power Systems, Safety, Feedback Control Systems, Magnetic Amplifiers, Rotating Machinery; Thursday—Chemical Industry in the South, Relays, Television Systems, Transmission and Distribution, Switchgear, Radio Communications, Petroleum Industry in the South; Friday—Transmission and Distribution, Communication Switching Systems, Cathodic Protection, Wire Communication Systems, General Industry Applications, Transformers.

ENTERTAINMENT

The Fall Meeting this year will give members and their guests the opportunity to visit glamorous New Orleans and to partake of the hospitality for which the South is famous. Full programs of entertainment will be provided for both ladies and members.

The week's festivities will begin with a cocktail party on Sunday evening at the International House. This will be a good opportunity to renew old acquaintances and make new ones. The smoker will be held on Tuesday night, and on Wednesday there will be a dinner-dance, dress optional, in the Tulane Room of the Jung Hotel.

Thursday has been set aside for a Gulf Coast "shrimp boil" at the Buena Vista Hotel in Biloxi, Miss. The trip will be made by busses, passing through the cypress swamp country of coastal Louisiana, the marsh and pine country of Mississippi, and along the residential Gulf Coast. Swimming may be enjoyed at the Buena Vista.

For those interested in golf, guest cards may be had for four famous courses, the New Orleans, Metairie, Colonial, and Audubon Country Clubs.

LADIES' SCHEDULE

The ladies, of course, are invited to the Sunday evening cocktail party. On Tuesday they will lunch at the New Orleans Country Club. For the afternoon, sightseeing tours of the French Quarter have been arranged. A buffet supper will be served at the Metairie Country Club, followed by canasta, bridge, and bingo.

Luncheon on Wednesday will be at the Patio Royal, after which the ladies will take a walking tour of the surrounding French Quarter. In the evening they will join the men at the dinner-dance.

On Thursday, the ladies are invited to the shrimp boil at Biloxi, and on Friday they will lunch at the Yacht Club on the shore of Lake Pontchartrain and then take a sightseeing tour through the new sections of the city and the suburbs.

For a limited group of the visiting ladies, interested in harbor activities, a trip on the *Good Neighbor* may be taken on Wednesday instead of the walking tour. Those wishing to take the harbor cruise should register early as the capacity of the vessel is limited.

INSPECTION TRIPS

The Trips Committee for the Fall General Meeting has completed final arrangements for a number of inspections of New Orleans and surrounding industry. Advance reservations for these trips should be made by means of the advance registration card. However, remaining available tickets will be obtainable at the Inspection Trips Desk. A nominal charge of $1.00 will be made to cover the cost of transportation to and from inspection sites. The only exception is the trip to the Godchaux Sugar Plant which includes luncheon and for which the charge will be $2.00.

For the trips to the Kaiser Aluminum Company, Rheem Manufacturing Company, and the Chrysler Corporation, passes will have to be prepared in advance and so advance registration by name is required.

Sewerage and Watrr Board Plant (Tuesday, October 14, 9:30 a.m. and 1:30 p.m.; 100 to 120 persons maximum; $1.00). The Sewerage and Water Board of New Orleans operates a complete miniature utility system generating the greater part of its own power, owning and operating its own underground and overhead distribution system supplying its various pumping stations, and so forth. Its duties are threefold: to purify and distribute drinking water to the city; to bring out all sewerage from the city; and to pump out all rainwater that falls in the city.

The trip to be conducted for the members of the AIEE will take the members first to Drainage Station Number 6, one of the largest drainage pumping stations in the world. Here may be seen the 14-foot Wood Screw Pumps developed by A. B. Wood, the present general superintendent of the Sewerage and Water Board, alongside the old vertical pumps that were the original equipment of this station. This station has a capacity of 6,410 cubic feet per second, or approximately 32,000,000 gallons per minute.

The second station to be visited is Station D. Here sewerage and drainage water both may be pumped at the same time but kept entirely separated. Here, also, are two large frequency changers allowing public utility power delivered at 60 cycles per second to be converted to 24 cycles per second power for the Sewerage and Water Board.

Several 2-unit synchronous motors allow cascading of frequencies to be used to obtain lower or higher speeds for various pumping conditions.

This trip is scheduled to precede a technical paper to be presented by L. T. Frantz, who for many years was associated with the system, and will give those members who avail themselves of the trip a better understanding of the paper.

The Kaiser Aluminum and Chemical Corporation's Chalmette Plant (Tuesday, October 14, Thursday, October 16, Friday, October 17, 9:30 a.m.; 40 persons maximum, no ladies;* $1.00). The Chalmette site was chosen because it met the several requirements for this type of plant almost ideally. Near-by natural gas fields supply an abundant, cheap fuel, large quantities of which are required in the reduction process. The plant is on the banks of the Mississippi River allowing direct delivery of raw materials with a minimum of handling.

The plant eventually will consist of about 75 buildings on a plant site of 280 acres.

* Because of safety regulations, the number of persons per trip will be limited to 40 and no ladies will be taken. Advance registration will facilitate the visit. Watches should be left at home.

Future AIEE Meetings

AIEE Participation in Centennial of Engineering
Congress Hotel, Chicago, Ill.
September 10–12, 1952
(*Final date for submitting papers—closed*)

Fall General Meeting
Jung Hotel, New Orleans, La.
October 13–17, 1952
(*Final date for submitting papers—closed*)

Middle Eastern District Meeting (*page 818*)
Commodore Perry Hotel, Toledo, Ohio
October 28–30, 1952
(*Final date for submitting papers—closed*)

AIEE Conference on Machine Tools
Ten Eyck Hotel, Albany, N. Y.
October 29–31, 1952

AIEE Special Technical Conference on Electrically Operated Recording and Controlling Instruments
Benjamin Franklin Hotel, Philadelphia, Pa.
November 17–18, 1952
(*Final date for submitting papers—closed*)

Joint AIEE-IRE-ACM Conference on Electronic Computers
Park Sheraton Hotel, New York, N. Y.
December 10–12, 1952

AIEE-IRE-NBS Conference on High-Frequency Measurements
Statler Hotel, Washington, D. C.
January 14–16, 1953

An old house in New Orleans' picturesque Vieux Carré

The total power generating capacity on the plant site will be 478,200 kw.

One of the impressive sights at this plant is the powerhouse containing two rows of vertical gas-burning diesel engines, each row containing 40 engines. These engines are directly connected to vertical d-c generators set under the engines. An advanced type of voltage control is applied to the generators, all of which operate in parallel to supply the aluminum "pots" with an amazingly large current.

Visitors will be able to see the reduction process carried on and the actual pouring of the "pigs" of aluminum that are the end product of this plant.

Higgins Industries, Inc. (Tuesday, October 14, 1:30 p.m.; 100 persons maximum; $1.00). Higgins Industries are known all over the world for the vast number of landing craft and PT boats built during World War II. They are now engaged in building boats, some of which contain unique and new types of electric equipment. Among these are a 65-foot tug and a 100-foot tug for the United States Navy and a 166-foot all-wooden nonmagnetic mine sweeper. All of the major structural parts of this boat are built up of fabricated wood.

In addition to the afore-mentioned craft, there is a mass-production schedule being carried out in the construction of 27-foot aluminum boats for the United States Army Engineers.

Celotex Corporation Plant (Tuesday, October 14, 1:30 p.m.; 80 persons maximum; $1.00). The New Orleans plant of the Celotex Corporation is the largest "board mill" in the world. Here the "bagass," that is, the ground-up and heretofore useless sugar cane stalks that are the residue of the sugar cane grinding mills, is used along with some other materials to make a variety of wall panels, refrigerator lining, and acoustical control panels. The New Orleans area is the ideal location for such a plant as it is close to the cane mills and has abundant natural gas supplies for the large quantities of heat which are used in the manufacturing process.

Celotex, the end product of this plant, has very good heat and sound insulating properties and has found many uses throughout the world.

The plant is situated on the west bank of the Mississippi River and on this trip members will have a chance to see the industry that has grown up in this area.

American Radiator and Standard Sanitary Plant (Wednesday, October 15, 9:30 a.m.; 80 persons maximum; $1.00). The American Radiator and Standard Sanitary Plant in New Orleans is a good example of how plants that were built during World War II for defense purposes may be adapted to peacetime uses. The plant was originally built to construct large seaplanes and therefore was situated on the banks of Lake Pontchartrain so that the completed seaplanes could be launched directly from the plant. In addition, good railroad facilities are available.

This plant has been adapted to the manufacture of a variety of vitreous china sanitary plumbing fixtures, complete from raw materials to finished product. The fixtures are made not only in white but in several colors.

Electricity plays an important part in the manufacturing processes and the members should enjoy a visit to this plant.

Rheem Manufacturing Company (Wednesday, October 15, 1:30 p.m., Thursday, October 16, 1:30 p.m.; 40 persons maximum; $1.00). The Rheem Manufacturing Company's New Orleans plant is a pilot plant for the far-flung manufacturing facilities of this company. This plant contains the largest lithographing press of its type in the world. Flat steel sheets of sizes up to those required for a standard 55-gallon oil drum are lithographed in several colors and then rolled into shape and welded.

The equipment used was developed especially for this work and the welding devices are all electronically controlled for precise heating and timing.

The Nine Mile Point Generating Station (Wednesday, October 15, 1:30 p.m.; 80 persons maximum; $1.00). The Nine Mile Point Generating Station of the Louisiana Power and Light Company is typical of the modern generating station that is being built throughout this area to meet the rapid load increases due largely to the growth of industry in the deep South.

The climate in this section is particularly suitable for the so-called "outdoor" station of which this is a good example and of course this allows considerable savings in construction and maintenance costs.

The first unit in this plant has been in operation for about a year. It is a 60,000-kva unit embodying all of the latest features for reliable and economical operation. The second unit, of 100,000-kva capacity, will be about 50 per cent complete when the members see it, thus they will be able to appreciate some of the construction problems peculiar to this part of the country.

One of the more interesting features of this station is the "functional"-type control. A single control board has mounted on it a diagram of all the steam generating and utilizing equipment, along with the electric generating and auxiliary equipment. All of the indicating instruments are mounted in their proper relative locations and the recording instruments are mounted on the rear of this panel. This control board allows one or two men to observe the functioning of all the plant equipment and to keep it operating at maximum efficiency.

Falstaff Brewing Corporation Plant Number 4 (Wednesday, October 15, 2:00 p.m.; 100 persons maximum; $1.00). The Falstaff Brewing Corporation Plant Number 4 in New Orleans recently completed a modernization and expansion program that makes it one of the largest and finest of its kind in the South, capable of producing more than 1,000,000 barrels of beer a year.

The various operations have been modernized to the highest degree allowing a steady flow of production. Even the incoming empty bottles are unpacked by mechanical hands and placed on conveyors which carry them through the washing process.

Members should find this trip very interesting as it furnishes a good example of how the application of electric equipment has made possible many improvements and savings in industrial plants.

Godchaux Sugars (Wednesday, October 15, Friday, October 17, 9:00 a.m.; 80 persons maximum; $2.00, including lunch; return 2:00 p.m.). This trip will permit many of those taking it to see a sugar mill, that is, a plant where the sugar cane is ground, for the first time. If the weather is favorable this fall, they probably will see the actual harvesting of the sugar cane, then the grinding, refining, and, finally, the packaging of the finished sugar.

The Godchaux Sugar Plant is about 50 miles from New Orleans in the middle of a large sugar plantation. The sugar cane from the immediate plantation is supplemented by cane from near-by plantations, and during that part of the year when there is no harvesting in Louisiana, raw sugar is imported from Cuba so that the refinery runs the year around.

This plant has been modernized, so that there is now installed equipment ranging from fairly old equipment to most modern. One of the triumphs of ingenuity is the development of methods whereby refined sugar may be stored in bulk so that the packaging plant can be operated at a steady rate, obviating the troubles of seasonal operation.

Michaud Plant, Chrysler Corporation (Thursday, October 16, 9:00 a.m.; 120 to 150 persons maximum; $1.00). The Michaud Plant of the Chrysler Corporation is engaged in manufacturing engines to be used in tanks for the United States Army.

The building that houses this plant is one of the largest single buildings in the world, the roof having an area of approximately 43 acres. The plant is equipped with many varieties of high-production-rate precision machine tools of the latest type. One interesting feature of this plant will be the aluminum foundry which may be completed by the time this inspection trip is made.

The engine produced here is a 12-cylinder V-type air-cooled gasoline engine with a specially designed cooling system for this application. After the engine is completed, it is set up in one of many very complete test stands and given a thorough test run. If it passes this test successfully, it is partially torn down, carefully inspected, reassembled, and given a final test.

One of the many difficult problems that has arisen is the extensive dehumidification system necessitated by the damp climate.

The very high connected electrical loading

(Continued on page 816)

Prize Rules for AIEE Technical Papers Revised by Board of Directors

The following rules for the award of prizes for AIEE technical papers were approved by the Board of Directors June 23, 1949, and revised June 26, 1952.

INTRODUCTION

The AIEE has established a series of prizes which are available for annual award to members for outstanding papers presented at its meetings.

Each prize consists of a sum of money and/or a Certificate of Award. Appropriate recognition will be given in *Electrical Engineering* and in the AIEE "Year Book."

PRIZES

The following summarizes the awards which are available each year in each classification.

1. *Institute*

Class	First Prize	Second Prize
(*a*). Power	$100 and certificate	Certificate
(*b*). Industry	$100 and certificate	Certificate
(*c*). Communication	$100 and certificate	Certificate
(*d*). General Application	$100 and certificate	Certificate
(*e*). Science and Electronics	$100 and certificate	Certificate
(*f*). Best Student Paper	$100 and certificate	Certificate

2. *District*

Class	First Prize	Second Prize
(*a*). Best paper, any class	$75 and certificate	$50 and certificate
(*b*). Best paper presented by undergraduate Student member in District competition	$25 and certificate	Certificate

3. *Section*

$100 to be divided at the discretion of the Section with a maximum of $50 for any one prize, and certificate for each winner.

4. *Branch* (*Undergraduate*)

Class	First Prize	Second Prize
(*a*). Best Paper	$10 and certificate plus an allowance of 15 cents per mile one way for 900 miles or less and 10 cents per mile one way for remaining distance to the District Student prize paper competition	Certificate

Coauthors will split prize; each will receive a certificate. Equivalent gift may be substituted for the monetary prize.

PERSONS ELIGIBLE

To compete for these awards requires that the author (or one of the coauthors) be a member of the Institute, a Fellow, Member, Associate Member, Affiliate, or enrolled student member in good standing, and that the paper be presented at a qualified technical meeting of the AIEE; the Institute Winter, Summer, Fall, or Pacific General Meeting; District meeting; Special Technical Conference; Section (including technical group and Subsection) meetings; or Branch meetings. District, Section, and Branch prizes will be limited to authors who are resident within the respective territories covered.

ENTRANCE REQUIREMENTS

All papers presented at District, Section, Branch, or Student meetings will be considered for *Institute* and *District* awards, if submitted in triplicate to the Institute or District Secretary before September 15, of the following administrative year, and accompanied by a written statement as to when and where the papers were presented. The date of consideration for District awards may be varied by the District Executive Committee at its discretion.

When three or more papers are submitted for *Section* or *Branch* competition to the respective secretaries, arrangements shall be made for presentation before the Section or Branch at a meeting set aside for that purpose and committees selected to judge each such contest.

All papers approved by the Technical Program Committee which are presented at the Winter, Summer, Fall, or Pacific General Meetings of the Institute will be considered for *Institute* prizes without formal offering in competition.

All papers approved by the Technical Program Committee as described in the foregoing and those which are approved by the Technical Program Committee and presented at District meetings will be considered for *Institute* and *District* prizes without formal offering in competition.

GENERAL INFORMATION

1. *Presentation of Awards*

Presentation of awards will be made: annually at the regular Winter General Meeting for Institute prizes; at a meeting within the District for District prizes or at a meeting designated by the District Executive Committee; at appropriate Section meetings for Section prizes; and at Branch meetings for Branch prizes.

2. *Where Insufficient Papers Are Submitted*

When in the opinion of the Committee on Award the number of papers in a given class is not sufficient to constitute a real competition, the award will be withheld. In this case these papers will be considered with the others which are presented in the following year.

3. *Date of Presentation*

All prizes will be awarded on the basis of papers presented during the administrative year, August 1 to July 31. (Except as varied by District Executive Committee to cover District competition and by Sections to cover Section competition.)

BASIS OF GRADING

1. *Institute, District, and Section Papers*

The valuations which govern the grading of papers for the purpose of awarding best paper prizes are

Analysis of subject—15 per cent
Logical presentation—15 per cent
Originality—15 per cent
Unity—15 per cent
Value in electrical engineering field—40 per cent
(*Except in Section competition where value will be rated 20 per cent and oral presentation 20 per cent*)

2. *District Branch and Branch Papers*

As the objective of Student papers differs from that of the more advanced papers, the basis of grading given in the following has been adopted. It is not the primary purpose of Student papers to contribute to the technical advancement of the profession; they should constitute a vehicle for the training and stimulation of future contributors to the profession. To this end greater emphasis has been placed on written presentation and the exercise of engineering thinking than on technical value. Written presentation shall be given a weighting of two compared with one for oral presentation.

A. *Basis for Grading Written Presentation:*

Originality—20 per cent
Survey of subject (analytical procedure)—15 per cent
Importance—15 per cent
Appropriateness—10 per cent
Mode of Expression—

(*1*). Logical organization of material for clarity, forcefulness, and interest. Appropriate headings are essential. (10 per cent)

(*2*). Concise and coherent expression of thoughts in good English and with proper choice of words. (10 per cent)

(*3*). Effective and judicious use of pictorial and graphical presentation. (10 per cent)

Adequate introduction and closure—10 per cent

B. *Basis of Grading for Oral Presentation:*

Speaking technique—35 per cent
Style (organization of material)—35 per cent
Introduction and conclusion—15 per cent
Discussion—15 per cent

COMMITTEE ON AWARD OF INSTITUTE PRIZES

1. *Institute*

The Committee on Award of Institute Prizes shall be appointed by the Institute President and shall consist of not less than five Members or Fellows of the Institute.

2. *District*

The Committee on Award of District Prizes shall be appointed by the District Vice-President and shall consist of not less than three Members or Fellows of the Institute. Judges of oral presentation of Student papers need not be same as judges of written presentation and they may include Associate or non-Institute members when necessary.

3. *Section*

The Committee on Award of Section Prizes shall be appointed by the Section Chairman and shall consist of not less than three Members or Fellows of the Institute.

4. *Branch*

The Committee on Award of Branch Prizes shall be appointed by the Student Counselor and shall consist of not less than three Associates, Members, or Fellows. When necessary, a non-Institute member may be selected.

EFFECTIVE DATE OF RULES

These prize rules became effective with the administrative year beginning on August 1, 1949.

PROCEDURE FOR REVISION

These rules are subject to revision annually by the Board of Directors of the Institute.

(*Continued from page 814*)

of this plant has brought out some difficult problems and it is hoped that the members will be able to see their solutions.

HOTEL INFORMATION

Rooms will be available at the headquarters hotel, the Jung Hotel, at the following rates. However, all requests for room reservations must be addressed to H. A. Schaeffer, Jr., 2518 Pressburg Street, New Orleans 22, La., as the member hotels of the New Orleans Hotel Association do not accept direct requests in connection with the scheduling of conventions.

Single room (one person)	$6.00, $7.00, $9.00
Double room, twin beds (two people)	$9.00, $10.00, $11.00, $12.00
Double room, double bed (two people)	$8.00, $9.00, $10.00, $11.00
Suites	$20.00, $25.00, $30.00, $35.00, $50.00

Eighth National Electronics Conference to Meet in Chicago, September 29–October 1

The eighth annual National Electronics Conference will convene at the Sherman Hotel in Chicago, Ill., September 29–October 1, 1952. This conference is sponsored by the AIEE, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern University, and the University of Illinois, with Purdue University, the University of Wisconsin, and the Society of Motion Picture and Television Engineers participating.

The greatly expanded technical program for the conference offers some 99 papers covering a broad field of electronic research, development, and industrial application, and will be supplemented by more than 75 exhibits by manufacturers and institutions foremost in the electronics field.

On the social side, the conference will sponsor three luncheons featuring prominent speakers, an evening banquet, and a full 3-day social program for the ladies. Two evenings will be left open for viewing the exhibits or visiting the various entertainment spots within the vicinity of the Sherman Hotel.

Advance registration may be made by addressing: National Electronics Conference, Inc., Karl Kramer, Executive Secretary, 852 East 83d Street, Chicago 19, Ill.

Tentative Technical Program

National Electronics Conference, Chicago, September 29-October 1

Monday, September 29

9:45 a.m. Servomechanism Theory

The Application of Nonlinear Techniques to Servomechanisms. *K. C. Mathews, R. C. Bue*, Cook Research Laboratories, Chicago, Ill.

A Study of the Transient Response of a Single-Point Nonlinear Servomechanism. *K. N. Burns*, University of Illinois, Urbana

Servo System Comparators. *M. Cooperstein*, Sylvania Electric Products, Inc., Bayside, N. Y.

Synthesis of Compensation Networks for Carrier-Frequency Servomechanisms. *R. S. Carlson, J. G. Truxal*, Purdue University, Lafayette, Ind.

Interstage Circuit Synthesis. *L. Weinberg*, Hughes Aircraft Company, Culver City, Calif.

9:45 a.m. High-Frequency Electron Tubes

Design Features of a New 14,500-17,500-Megacycle Reflex Klystron. *G. C. Dalman*, Sperry Gyroscope Company, Great Neck, N. Y.

Automatic Frequency Control of High-Power Klystrons. *T. A. Wilson*, Hughes Aircraft Company, Culver City, Calif.

General Design Considerations of a Cavity-Type Power Amplifier. *W. S. Elliott*, Collins Radio, Cedar Rapids, Iowa

An Investigation of a Space Harmonic Traveling-Wave Amplifier. *P. Lally*, Sperry Gyroscope Company, Great Neck, N. Y.

Operation of the Traveling-Wave Tube in the Dispersive Region. *L. A. Roberts, S. F. Kaisel*, Stanford University, Stanford, Calif.

9:45 a.m. Audio

Program prepared in co-operation with the Institute of Radio Engineers (IRE) Professional Group on Audio

High-Power Audio Amplifiers. *L. F. Dein, H. J. Morrison*, Westinghouse Electric Corporation, Baltimore, Md.

Analogue for Loudspeaker Design. *J. J. Baruch, H. C. Lang*, Massachusetts Institute of Technology, Cambridge

A Ceramic Vibration Pickup of High Sensitivity. *E. V. Carlson*, Shure Brothers, Inc., Chicago, Ill.

Direct Measurement of the Efficiency of Loudspeakers by Use of a Reverberation Room. *H. C. Hardy, H. H. Hall, L. G. Rowe*, Armour Research Foundation, Chicago, Ill.

Interference Effects in Magnetic Recording Heads. *A. H. Mankin*, Shure Brothers, Inc., Chicago, Ill.

9:45 a.m. Industrial Measurements

A Differential X-Ray Absorption Gauging System of High Sensitivity. *G. M. Ettinger*, Standard Electronic Research Corporation, New York, N. Y.

Automatic Metal Gauging Using X Rays. *J. F. Howell*, General Electric Company, Milwaukee, Wis.

Electronic Circuit Problems in Electromagnetic Flow Measurements. *W. R. Hegg, E. Mittelmann, D. S. Scherr*, Consulting Engineers

Nondestructive Nuclear Measurements of Waveguide Plating Thickness. *H. V. Watts, C. A. Stone, L. Reifel*, Armour Research Foundation, Chicago, Ill.

12:30 p.m. Luncheon in the Ballroom

Keynote Address: "Electronics for Defense and Industry"

2:30 p.m. Magnetic Amplifiers and Servo Applications

A Critical Comparison of Methods of Analysis of Magnetic Amplifiers. *L. A. Finzi, G. F. Pittman, Jr.*, Carnegie Institute of Technology, Pittsburgh, Pa.

Compensation of a Magnetic Amplifier Servo System. *H. H. Woodson, A. E. Schmid, C. V. Thrower*, United States Naval Ordnance Laboratory, Silver Spring, Md.

The Use of Servo Techniques in Designing Amplitude-Stabilized Oscillators. *A. W. Dickson*, Southwest Research Institute, San Antonio, Tex.

The Design of a Stabilized Camera Mount. *P. J. Herman*, Goodyear Aircraft Corporation, Akron, Ohio

2:30 p.m. Television

Effects of Noise on National Television System Committee Color Standards. *C. H. Jones*, Westinghouse Electric Corporation, East Pittsburgh, Pa.

An Application of Autocorrelation Theory to the Video Signal of Television. *M. B. Ritterman*, Sylvania Electric Products, Inc., Flushing, N. Y.

A 42-Tube Compatible Color Television Receiver. *K. E. Farr*, Westinghouse Electric Corporation, Sunbury, Pa.

Design of Video Amplifiers for Optimum Transient Response. *W. K. Squires, H. L. Newman*, Sylvania Electric Products, Inc., Buffalo, N. Y.

Low Power Blocking Oscillators. *J. R. Clark*, Purdue University, Lafayette, Ind.

2:30 p.m. Equipment and Components Reliability

Reliability—What Are We Striving For? *W. D. McGuigan*, Stanford Research Institute, Stanford, Calif.

Aspects of Electronic Equipment Reliability. *Victor Harris*, Vitro Corporation of America, Silver Spring, Md.

Electronic Failure Prediction. *J. H. Mauy*, National Bureau of Standards, Washington, D. C.

Some Examples of Component Unreliability in Military Equipment. *O. C. Eliason*, Bell Telephone Laboratories, Murray Hill, N. J.

The Stress-Step Method of Obtaining Short-Term Life Ratings on Electronic Components. *A. P. Jaworski, W. T. Sackett, Jr.*, Battelle Memorial Institute, Columbus, Ohio

2:30 p.m. Waveguides

Electromagnetic Propagation Through Waveguides of Rhombical Cross Section. *W. B. Swift, T. J. Higgins*, The University of Wisconsin, Madison

Electromagnetic Transients in Waveguides. *G. I. Cohn*, Illinois Institute of Technology, Chicago

Cutoff Frequency for Circular Waveguides Containing Two Coaxial Dielectrics. *R. D. Tanaka*, Radio Corporation of America, Camden, N. J.

Duo-Dielectric Coaxial Waveguide. *R. E. Beam, D. A. Dobson*, Northwestern University, Evanston, Ill.

High-Power Delay Line for a Traveling Wave Amplifier or Oscillator. *J. F. Hull, G. Nesick*, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

Tuesday, September 30

9:45 a.m. Transistors

Junction Transistor Characteristics at Medium Frequencies. *L. J. Giacoletto*, Radio Corporation of America, Princeton, N. J.

Properties of Junction Transistors. *K. D. Smith*, Bell Telephone Laboratories

A Transistor Reversible Binary Counter. *R. L. Trent*, Bell Telephone Laboratories

A Look at Russian Radio and Electronics. *G. B. Dow*, Office of Naval Research, Washington, D. C.

9:45 a.m. Radar and Radio Navigation

Continuous Indicating Loran. *R. Williams*, Sperry Gyroscope Company, Great Neck, N. Y.

Automatic Track-While-Scan Radar Range System. *H. L. Schauer*, Cook Research Laboratories, Skokie, Ill.

A Quality Factor for Radar Cathode-Ray Tube Presentations. *A. F. Bischoff*, General Electric Company, Schenectady, N. Y.

Phase and Gain Stabilization in Matched Channel Receivers. *W. E. Michel, T. R. O'Meara, H. D. Webb*, University of Illinois, Urbana

9:45 a.m. Circuits I

An Alternative Approach to Optimum Filtering. *E. W. Pike*, Raytheon Manufacturing Company, Waltham, Mass.

Synthesis of a Dynamically Variable Electronic Filter. *J. G. Truxal, J. N. Warfield*, Purdue University, Lafayette, Ind.

A Relation Between Susceptance Slope and Selectivity for Oscillator Design. *W. A. Edson*, Georgia Institute of Technology, Atlanta; *R. D. Teasdale*, Radio Corporation of America, Camden, N. J.

The Approximation of Arc Tangent (ω) With a Linear Electrical Network by Use of a Continued Fraction Expansion. *D. L. Finn*, Purdue University, Lafayette, Ind.

A Method of Evaluation of the Quasi-Stationary Distortion of Frequency Modulation Signals in Tuned Interstages. *J. J. Hupert*, A.R.F. Products, Inc., River Forest, Ill.

9:45 a.m. Components, Assembly and Measurements

Use of Ferromagnetic Materials in Electronic Tuning of Radio-Frequency Components. *S. Shiber*, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

Liquid Dielectric Radio-Frequency Coaxial Cables. *R. M. Soria, C. C. Camillo, J. G. Kristlas*, American Phenolic Corporation, Chicago, Ill.

Miniature Wiring for Electronic Applications. *J. M. Caller*, Raytheon Manufacturing Company, Waltham, Mass.

Printed Circuits and the Automatic Factory. *R. Gerhold*, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

Measurements on an Amplitude-Modulated Crystal-Controlled Magnetron Transmitter. *L. L. Kovo*, Radio Corporation of America, Camden, N. J.

12:30 p.m. Luncheon in the Ballroom

2:30 p.m. Semiconductors

Semiconducting Films. *W. M. Bacher, K. Lark-Horovitz*, Purdue University, Lafayette, Ind.

Microwave Measurements on Germanium Semiconductors. *F. A. D'Altroy, H. Y. Fan*, Purdue University, Lafayette, Ind.

The Determination of the Resistance-Temperature Characteristics of Bulk Semiconductors by the Pulse Heating Method. *R. B. McQuistan*, Purdue University, Lafayette, Ind.

Cadmium Sulfide as a Crystal Rectifier. *G. Strull*, Northwestern University, Evanston, Ill.

2:30 p.m. Memory Tubes and Tube Reliability

Development of an Improved Graphechon Storage Tube. *W. T. Dyall, G. R. Fodor, M. D. Hurst*, Radio Corporation of America, Lancaster, Pa.

Performance Characteristics of the Raytheon Recording Tube. *R. C. Hergenrother, A. S. Luftman*, Raytheon Manufacturing Company, Waltham, Mass.

Reliability of Filamentary Subminiature Tubes. *R. Wood*, Raytheon Manufacturing Company, Newton, Mass.

Improving Gas Tube Grid Circuit Reliability. *J. H. Bussell*, Electrons, Incorporated, Newark, N. J.

2:30 p.m. Circuits II

Frequency Feedback. *H. E. Hollmann*, United States Naval Air Missile Test Center, Point Mugu, Calif.

The Dual-Input Parallel-T Network. *C. F. White, K. A. Morgan*, Naval Research Laboratory, Washington, D. C.

Harmonic Insensitive Rectifiers for A-C Measurements. *R. L. Frank*, Sperry Gyroscope Company, Great Neck, N. Y.

A Meter for Measuring the Coefficient of Coupling of Intermediate-Frequency Transformers. *E. A. Saunders*, United States Military Academy, West Point, N. Y.; *G. R. Cooper*, Purdue University, Lafayette, Ind.

Simple Method of Coupling Toroidal Coils. *R. R. Darden, Jr.*, Raytheon Manufacturing Company, Point Mugu, Calif.

7:00 p.m. AIEE-IRE Banquet

Ladies invited. Dress informal.

Wednesday, October 1

9:45 a.m. Computers

Fundamental Characteristics of Digital and Analogue Units. *J. M. Salzer*, Hughes Aircraft Company, Culver City, Calif.

A Different Approach to Analogue Computation. *C. R. Bonnell*, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.

Interconversion of Analogue and Digital Data in Systems for Measurement and Control. *B. Lippel*, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

A 5-Channel Electronic Analogue Correlator. *M. J. Levin, J. F. Reintjes*, Massachusetts Institute of Technology, Cambridge

An Electronic Statistical Tabulator. *R. M. Stewart, Jr., A. R. Kassander, Jr.*, Iowa State College, Ames

9:45 a.m. Antennas

Ground Reflection Phase Error Characteristics of a Vertical Antenna. *H. Greenberg, D. Meierdierks*, Sylvania Electric Products, Inc., Bayside, N. Y.

Input Impedance of Folded Dipole Antennas. *R. E. Beam, P. Andrix*, Northwestern University, Evanston, Ill.

Yaw Measurements on Rotating Projectiles by Radio-Frequency Link. *S. J. Raff*, United States Naval Ordnance Laboratory, Silver Spring, Md.

Aircraft Corona Interference Variation With Altitude. *M. M. Newman, J. D. Robb*, Lightning and Transients Research Institute, Minneapolis, Minn.

9:45 a.m. Electronic Instrumentation

Automatic Ejection in Betatrons and Synchrotrons. *L. W. Von Tersch, R. L. Doty*, Iowa State College, Ames

A Stabilized Electronic Multiplier. *C. D. Morrill, R. V. Bunn*, Goodyear Aircraft Corporation, Akron, Ohio

An Electronic Wattmeter. *W. B. Boast*, Iowa State College, Ames

A Thermocouple Audio-Frequency Wattmeter. *J. D. Ryder, M. S. McVay*, University of Illinois, Urbana

Stable Frequency Dividers Using Thyrite Elements. *W. L. Hughes*, Iowa State College, Ames

12:30 p.m. Luncheon in the Ballroom, Sherman Hotel

2:30 p.m. Engineering Management

Program prepared in co-operation with IRE Professional Group on Engineering Management

General T. C. Rives, General Electric Company

H. A. Leedy, Armour Research Foundation

J. F. Byrne, Motorola, Inc., Chicago, Ill.

G. L. Haller, Pennsylvania State College

2:30 p.m. Coding and Recording Techniques

A System for Coding and Determining Time Relationships of Eight Random Repetitive Events. *D. R. Church*, United States Naval Ordnance Laboratory, Silver Spring, Md.

Pulse Group Coding and Decoding by Passive Networks. *R. F. Blake*, Naval Research Laboratory, Washington, D. C.

An Optical Position Encoder and Data Recorder. *J. N. Shive, R. E. Yeager, H. G. Follingstad*, Bell Telephone Laboratories

An Acoustic Depth Recorder for Use in Liquids Operating in the Fractional-Megacycle Frequency Range. *C. E. Goodall*, United States Naval Ordnance Laboratory, Silver Spring, Md.

An Automatically Calibrated Frequency Recorder of the Electronic Type. *W. E. Phillips*, Leeds and Northrup Company, Philadelphia, Pa.

2:30 p.m. Delay Lines and High-Frequency Test Equipment

High Characteristic Impedance Delay Lines for Fractional Microsecond Pulses. *W. S. Curley, E. F. Seymour*, United States Naval Ordnance Laboratory, Silver Spring, Md.

Vitreous Silica for Ultrasonic Delay Line Applications. *E. S. Pennell*, Bell Telephone Laboratories

A Wide-Range Pulse Generator for Laboratory Applications. *R. W. Frank*, General Radio Company, Cambridge, Mass.

An S-Band Sweep Generator and Test Set. *J. H. Klack, R. E. Larson*, Naval Research Laboratory, Washington, D. C.

Wide-Range Crystal-Controlled Frequency Calibrator. *J. F. Sterner*, Radio Corporation of America, Camden, N. J.

Engineers Meet September 3 for Centennial Convocation

A full program of activities, including a special engineering exhibit and a stage production depicting engineering advancement, has been planned in conjunction with the Convocation of the Centennial of Engineering—1952 which is expected to attract engineers from all over the world to Chicago this month. The convocation, from September 3 to 13, will be a feature of the celebration commemorating the founding of the first professional engineering society, the American Society of Civil Engineers, in 1852.

Major meetings at the Centennial will cover 12 broad fields of impact on modern living. These meetings will be open to all attending the convocation, as well as to the general public. In addition, technical sessions will be held by most of the 64 individual engineering societies actively identified with the convocation. In this respect, the AIEE has scheduled five sessions at the Congress Hotel, September 10–12. A tentative program of Institute-sponsored sessions appeared in the August issue (*EE, Aug '52, p 753*). As presently planned, they include one session in each of the divisions: General Applications, Power, Industry, Communication, and Science and Electronics Division.

By payment of a nominal registration fee, students and the public will be admitted to the general meetings at the Centennial. (However, registration at AIEE Sessions will be free.) To have the greatest impact on nontechnical participants, as well as on the engineers from all the various fields which will be represented at the Centennial, the papers to be presented will be broad in scope and indicate social implications of each phase of technological advance in such a manner as will be understood by the layman.

For more complete details, see *Electrical Engineering* for August, pages 752–4.

Background, Use Explained of Members-for-Life Fund

Under the Constitution and Bylaws of the Institute, members who have paid dues for 35 years, or who have reached the age of 70 and have paid dues for 30 years, become Members for Life, and are exempt from all future dues. Section 21 of the Bylaws requires that bills for dues be issued to each Member for Life until he has indicated his acceptance of the exemption from further payments.

Many Members for Life have chosen to continue paying dues. By action of the Board of Directors, in 1944, the dues received from all Members for Life since that year have been placed in a separate fund. The fund and the income from the investments are to be used only for such special purposes as will aid the objectives of the Institute. At least 25 per cent of each year's receipts are to be retained as an addition to the "capital" part of the fund for application to a nonrecurring project of suitable nature. The remainder of the yearly receipts are to be available for such annual recurring or other projects as may be established.

In the years 1946–51, inclusive, provisions were available for the District Branch Paper Prize winners in one-half of the Districts to attend the Summer General Meeting to present their papers, the regular travel expense allowance, plus a reasonable living expense allowance per day while at the meeting, being provided to the winners in the odd-numbered Districts in the odd-numbered years, and to the even-numbered Districts in the even-numbered years.

As of April 30, 1952, the book value of the Members-for-Life Fund was $14,685.66. Upon recommendation of the Committee on Members-for-Life Fund and approval of the Board of Directors, arrangements were made for the Branch Paper Prize winners in all Districts to attend the Summer General Meeting, effective for the 1952 meeting in Minneapolis. Winners from nine Districts attended.—*H. H. Henline, Secretary, AIEE*

Lamme Medal Nominations Must Be Submitted by December 1

Members of the Institute again are reminded that they have an opportunity to submit nominations for the 1952 Lamme Medal. All nominations must be received not later than December 1, 1952. Details regarding qualifications were published in the June 1952 issue of *Electrical Engineering*, page 563.

Middle Eastern District Meeting to Feature Management Session

Three days of activities of broad interest have been planned for the AIEE Middle Eastern District Meeting to be held October 28–30, 1952, in Toledo, Ohio. Headquarters hotel for the meeting will be the Commodore Perry.

Of particular interest should be the session on management. Several papers have been scheduled to show the engineer what his responsibilities are in human relations and executive development. Walker Cisler, president of the Detroit Edison Company, will address the general session on the same theme.

World's tallest refinery unit and first of its kind is the Sun Oil Company's new Houdriflow catalytic cracking plant at Toledo, Ohio, site of the coming Middle Eastern District Meeting

Technical sessions will present papers on the glass and automotive industries, rotating machines, industrial controls, power plant applications, and power system design. Also, because of the location of the meeting in Toledo, the AIEE Air Transportation Committee will sponsor several technical sessions at which papers will be presented by aircraft engineers from both the East and West Coasts.

Inspection trips have been planned for Wednesday and Thursday afternoon. These will include the Sun Oil Company refinery, Libbey Owens Ford Glass Company, Toledo Scale Company, and the Chesapeake and Ohio Railroad coal and ore docks.

An entertainment program has been arranged for both men and women. The ladies will enjoy inspection trips through the Libbey Glass plant and the Grace E. Smith Cafeteria, in addition to shopping trips and a visit to the Toledo Museum of Art. A dinner has been arranged for the ladies at the Toledo Women's Club.

A stag smoker has been planned for Tuesday evening, and on Wednesday evening there will be a banquet in the Commodore Perry Hotel. Grove Patterson, editor-in-chief of the *Toledo Blade* and world traveller, will be the after-dinner speaker.

The headquarters hotel, the Commodore Perry, has reserved a block of rooms for attending visitors. Rooms will be available also in the conveniently located Secor and Fort Meigs Hotels.

Honorary Chairman for the meeting is C. E. Ide, with M. W. Keck as General Chairman, and Roy Stott as Secretary-Treasurer.

Subcommittee chairmen are: L. E. Smith, *Scheduling*; J. W. Cofer, *Technical Program;* W. H. Schwalbert, *Inspection Trips;* D. L. Rexford, *Registration and Finance;* W. E. Boruh, *Entertainment and Publicity;* and Mrs. W. E. Boruh, *Ladies' Program.*

Further details may be obtained from the AIEE Meeting Committee, Toledo Edison Company, 420 Madison Avenue, Toledo 4, Ohio. Attention: Mr. W. Keck.

AIEE to Participate in ISA Cleveland Exhibit

The Instrument Society of America will hold its exhibit in Cleveland, Ohio, September 9–10, 1952. AIEE participation will include two technical sessions which have been arranged by a subcommittee of the AIEE Instruments and Measurements Committee, headed by A. E. Hornfeck of the Bailey Meter Company, Cleveland, Ohio. The following is a program of the Institute-sponsored sessions:

Tuesday, September 9

10:00 a.m. Electric Recording Instruments

Presiding: A. J. Hornfeck

The Requirements and Design for a D-C Null Detector. *F. L. Maltby*, The Bristol Company, Waterbury, Conn.

A High-Speed Direct-Writing Oscillograph. *A. R. Eckels*, North Carolina State College, Raleigh; *I. S. Blumenthal*, Yale University, New Haven, Conn.

A Smoke Density Recorder Using the Bolometer. *J. F. English*, Bailey Meter Company, Cleveland, Ohio

Wednesday, September 10

2:00 p.m. Electric Instruments and Measurements

Presiding: H. C. Martin, Ambos Jones Company, Cleveland, Ohio

Electrometer Tubes and Their Applications to Basic Instrumentation. *D. L. Collins*, Victoreen Instrument Company, Cleveland, Ohio

Applications of Beta Radiation Gauges to Industrial Process Control. *F. M. Alexander*, Industrial Nucleonics Corporation, Columbus, Ohio

Shore-Based Radar for Harbor Surveillance. *E. J. Isbister*, Sperry Gyroscope Company, Great Neck, N. Y.

COMMITTEE ACTIVITIES

Note. Because of the changeover in committee personnel, no items on committee activities are included in this issue.

AIEE PERSONALITIES.....

L. F. Hickernell (AM '25, F '34), chief engineer, Anaconda Wire and Cable Company, Hastings-on-Hudson, N. Y., has been named Chairman of the newly formed Technical Operations Committee of the AIEE. Mr. Hickernell, a native of Middletown, Pa., received the degree of bachelor of arts from Grinnell College in 1920, and that of bachelor of science in electrical engineering from Massachusetts Institute of Technology (MIT) in 1922. While in college he was employed by the Iowa Light, Heat and Power Company, Grinnell, Iowa, in various capacities. Upon graduation from MIT, he joined the

L. F. Hickernell

graduate student engineer course of the General Electric Company, Lynn, Mass. In 1923 he entered the engineering department of the Consumers Power Company, Jackson, Mich., as assistant investigations engineer in the electrical department. In 1924 he became assistant investigations engineer of the successor company, the Commonwealth Power Corporation of Michigan. He became general engineer in the electrical engineering department in 1927. Stevens and Wood, Inc., succeeded this company in 1929, and in 1930 this concern was in turn succeeded by Allied Engineers, Inc. Mr. Hickernell continued as general engineer with these concerns until the disbandment of the latter organization in 1931. In that year he joined Anaconda Wire and Cable Company as electrical engineer. He became chief engineer in 1933. He is a very active member of the AIEE, having served in many capacities. He has served on the following Institute committees: Electric Machinery (1929–33); Protective Devices (1929–32); Power Transmission and Distribution (1930–47); Publication (1934–35, 1951–53); Board of Examiners (1941–53); Insulated Conductors (1947–53, Chairman 1947–49); Standards (1947–49); Technical Program (1947–50); Power Division, Power Co-ordinating (1947–52, Chairman 1949–51); Planning and Co-ordination (1949–50, 1952–53); Award of Institute Prizes (1949–50); Technical Advisory (1950–52, Chairman 1951–52); and Public Relations (1952–53). He has served also on many committees of the former National Electric Light Association, the American Society for Testing Materials, National Research Council, and committees of the Insulated Power Cable Engineers Association. The new Committee on Technical Operations will be co-ordinating agency for the AIEE's five technical divisions, which represent 39 technical committees; and will supervise all technical affairs of the Institute. It is a merger of the Technical Advisory Committee and the Technical Program Committee, with the addition of the Chairmen of the Committees on Standards, Education, Research, Publication, Management, Safety, and Award of Institute Prizes.

H. S. Osborne (AM '10, F '21, Member for Life), chief engineer, American Telephone and Telegraph Company, New York, N. Y., retired August 31, 1952. Dr. Osborne was born in Fayetteville, N. Y., on August 1, 1887, and received from Massachusetts Institute of Technology the degrees of bachelor of science in 1908 and doctor of engineering in 1910. He joined the American Telephone and Telegraph Company in 1910 as engineer in the transmission and protection department, became assistant to the transmission and protection engineer in 1914, and transmission engineer in 1920. In 1939 he was appointed operating results engineer, and the following year plant engineer. He became chief engineer in 1943. Dr. Osborne is a past-president of the Institute (1942–43) and served as a director from 1938–42. He has served the AIEE on the following committees: Standards (1917–28, Chairman 1923–26, ex officio 1949–50), Technical Program (1924–25, 27–29, 31–34, 36–41, Chairman 1936–39), Education (1928–31), Edison Medal (1935–43, 47–52), Award of Institute Prizes (1936–40, Chairman 1936–39), Publication (1936–39), Co-ordination of Institute Activities, Planning and Co-ordination (1936–39), Institute Policy (1938–42), Headquarters (1939–42), Finance (1939–42, Chairman 1939–42), Executive (1939–45, Chairman 1942–43), AIEE Retirement System, Board of Trustees (1945–51), and Volta Scholarship Trustee (1949–55, Chairman 1949–52), and many others. He was AIEE representative or alternate on the Standards Council of the American Standards Association (1923–47, Chairman 1943–45); representative on the Electrical Standards Committee of ASA (1932–42) and on the American Association for the Advancement of Science (1938–39). He has also been Vice-President of the United States National Committee of the International Electrotechnical Commission. Dr. Osborne is a

H. S. Osborne

fellow of the Acoustical Society of America, American Physical Society, American Association for the Advancement of Science, Institute of Radio Engineers, and a member of the American Society for Engineering Education, and Tau Beta Pi.

R. F. Chamberlain (AM'20, M'38), professor of electrical engineering and personnel officer of the College of Engineering, Cornell University, Ithaca, N. Y., retired July 1, 1952. He has been named professor of electrical engineering, emeritus. A native of Newark Valley, N. Y., Professor Chamberlain attended Phillips Exeter Academy before entering Cornell. Following his graduation in 1908, he taught for 2 years at Purdue University, Lafayette, Ind., and in 1911 joined the Cornell faculty. He was chief supervisor of Engineering Science Management War Training in the Southern Tier area of New York State from 1941–45 and was on the War Manpower Training Council for the Elmira-Binghamton area from 1943–45. Professor Chamberlain had been personnel officer of the College of Engineering since 1942 and assistant dean since 1946. He is a member of the American Society for Engineering Education, Eta Kappa Nu, and Tau Beta Pi. He has been a member of the executive committee of the North Eastern District of the AIEE and was three times chairman of the Ithaca Section. He served on the following Institute committees: Industrial and Domestic Power, General Power Applications (1924–25, 36–38), Industrial Power Applications (1938–42), and Education (1930–1931).

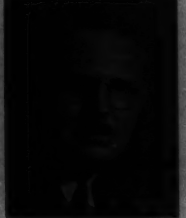
E. M. Williams (AM '40, M'47), professor of electrical engineering, Carnegie Institute of Technology, Pittsburgh, Pa., has been appointed Head of the Department of Electrical Engineering. A native of New Haven, Conn., Dr. Williams earned the bachelor of engineering degree with high honors from Yale University in 1936 and received the doctor of philosophy degree from Yale in 1939. From 1939 to 1942 he served as an instructor in electrical engineering at Pennsylvania State College. During the war years, Dr. Williams served as branch engineer with the Development Branch, Special Projects Laboratory at Wright Field. There he worked on radar, development of radio countermeasures, radio control for guided missiles, and infrared systems. In recognition of his achievement, Dr. Williams was presented the President's Certificate of Merit. In 1946 he was voted the outstanding young electrical engineer of the United States. Dr. Williams has been a member of the Carnegie faculty since 1945. He was made professor of electrical engineering in 1949. He serves as a consultant on electronic techniques for a number of large industrial firms. Dr. Williams is a member of Sigma Xi, Tau Beta Pi, Eta Kappa Nu, the Institute of Radio Engineers, and the American Society for Engineering Education.

D. D. Smalley (AM '20, F'47), vice-president in charge of operations, Pacific Gas and Electric Company, San Francisco, Calif., was elected president of the Pacific Coast Electrical Association at the association's annual convention held recently at Coronado, Calif.

After graduating from the University of California in 1910, he worked first for Westinghouse Electric Corporation, East Pittsburgh, Pa., as an engineering apprentice. A year later he became associated with Merced River Power Company, which was merged with San Joaquin Light and Power Corporation. In 1919 he was made division superintendent of Midland Counties Public Service Corporation, a subsidiary of San Joaquin Light and Power. In 1934 he was named general superintendent of the San Joaquin and Midland Counties systems, which were absorbed by Pacific Gas and Electric. He was promoted to superintendent of the Central Area in 1944 and was made engineer of electric operation in 1946. In 1947 he was advanced to his present post. He is a member of the San Francisco Engineers Club and the Pacific Coast Gas Association. Mr. Smalley has served the Institute on the Management Committee (1949–50).

Joseph Talla (AM'21), power plant superintendent, United States Bureau of Reclamation, Parker Dam, Calif., retired June 30, 1952. Mr. Talla received the Department of the Interior's commendable service award on his retirement as a result of his responsibility for the efficient operation and minor electrical maintenance of the Parker Dam power plant and switchyard since December 1942. Mr. Talla joined the Bureau of Reclamation on the Salt River project at Phoenix, Ariz., in 1914, serving there until 1917, when he left government service. He returned to the Bureau in 1928 and since then has held positions on the Minidoka project at Burley, Idaho; Boulder Canyon project at Boulder City, Colo.; Buffalo Rapids project at Glendive, Mont.; the Kendrick project at Seminole Dam, Wyo.; and the Parker Dam power project at Parker Dam, Calif.

C. S. Purnell (AM'29, M'35), manager, Eastern Agency and Construction Department, Westinghouse Electric Corporation, New York, N. Y., has been named Eastern District manager of the Electric Utility Department. Mr. Purnell was born in Frostburg, Md., June 17, 1902. He joined Westinghouse in 1922 as a graduate student at East Pittsburgh, Pa., following his graduation from Washington College. He was transferred to the New York office in 1927 as an application engineer for the Transportation Division, and later was assigned to a similar post with the Industrial Division. In 1946, he was appointed New York supervisor of the general industry section, Industrial Division. Mr. Purnell is a very active member of the AIEE, having served as vice-president, District 3 (1950–52), as a director (1950–52), and on the following committees: Sections (1943–52, Chairman 1951–52), Headquarters (1948–50, Chairman 1948–50), Edison Medal (1950–52), Finance (1950–52), and Executive (1951–52).



C. S. Purnell

H. E. Thompson (AM '26, M '30), quality control manager, Anaconda Wire and Cable Company, Hastings-on-Hudson, N. Y., has been named director of research for the company and chairman of the Research and Development Committee. Mr. Thompson joined Anaconda Wire and Cable Company in 1932, after having spent the years from 1919 to 1931 with the Brooklyn Edison Company. In 1939 he became supervisor of the Engineering Laboratories at Anaconda's Hastings mill and was made chief inspector of all plants in 1942. He is a member of the American Society for Quality Control.

Samuel Heller (AM '46), chief engineer, Consolidated Electric Motor Company, New York, N. Y., has joined the American Rectifier Corporation, New York, as chief engineer. Mr. Heller is a member of the American Society of Tool Engineers and the Institute of Radio Engineers.

E. T. B. Gross (AM '34, F 48), professor of power systems engineering, Illinois Institute of Technology, Chicago, has been elected national vice-president of Eta Kappa Nu. He will automatically become president for 1953–54. Dr. Gross is a member of Sigma Xi and Tau Beta Pi. An active member of the AIEE, he has served on the following committees: Relays (1947–52), Protective Devices (1947–48), System Engineering (1949–50), and Transmission and Distribution (1951–52).

MEMBERSHIP • • •

Recommended for Transfer

The Board of Examiners at its meeting of July 17, 1952, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the Secretary of the Institute. A statement of valid reasons for such objections, signed by a member, must be furnished and will be treated as confidential.

To Grade of Member

Adams, C. M., development engr., General Electric Co. Pittsfield, Mass.
Bartolotta, J. J., instrumentation engr., Sverdrup & Parcel, Inc., St. Louis, Mo.
Bent, E. D., chief engr., wire & cable div., Northern Electric Co., Ltd., Montreal, Quebec, Canada
Bourassa, W. O., staff elec. engr., Paramount Pictures Corp., Hollywood, Calif.
Bunte, H., engr., Commonwealth Edison Co., Chicago, Ill.
Cronin, W. F., engr. aviation acc., General Electric Co., Los Angeles, Calif.
Cross, F., elec. engr. & supervisor, Rohm & Haas Co., Knoxville, Tenn.
Davis P. C., application engr., Westinghouse Electric Corp., Boston, Mass.
DeNise, D. D., supervising senior engr., lighting dept., City of Seattle, Wash.
Egerman, A. F., electronics engr., San Francisco Naval Shipyard, San Francisco, Calif.
Elliott, A. H. R., service engr., Canadian Westinghouse Co., Ltd., Vancouver, British Columbia, Canada
Fink, J. C., asst. to vice-pres., Westinghouse Electric Corp., Pittsburgh, Pa.
Fink, Louis, III, transmission engr., The Bell Telephone Co. of Pennsylvania, Philadelphia, Pa.
Frets, O. G., chief engr., San Antonio General Depot, San Antonio, Tex.
Frohardt, A. E., mgr. motor engg. div., Wagner Electric Corp., St. Louis, Mo.
Fuller, F. F., application engr., General Electric Co., Denver, Colo.
George, G. T., engr., General Electric Co., Richmond, Va.
Gibson, J. V., meter & relay engr., Brazos River Transmission Electric Cooperative, Inc., Waco, Tex.
Gummo, R. L., senior design engr., Louis Allis Co., Milwaukee, Wis.
Healey, A. J., engr., Canadian Brazilian Services, Ltd., Toronto, Ontario, Canada
Howell, A. L., chief elec. engr., Consolidated Western Steel Corp., Houston, Tex.
Houle, E. A., application engr., The Electric Storage Battery Co., Philadelphia, Pa.
Hutton, R. E., chief engr., Gleason Avery, Inc., Auburn, N. Y.
Ivy, J. G., elec. engr., International Minerals & Chemical Corp., Chicago, Ill.
Jacobsen, A. E., elec. engg. instructor, University of Washington, Seattle, Wash.
Kester, C. D., manager, Westinghouse Electric Corp., York, Pa.
Kingston, C. R., consulting & application engr., Westinghouse Electric Corp., Philadelphia, Pa.
Kirby, L. W., chief, elec. design unit, U. S. Corps of Engineers, Norfolk, Va.
Lambert, J. B., pile technologist, General Electric Co., Richland, Wash.
Lewis, H. S., chief distribution engr., Central Vermont Public Service Corp., Rutland, Vt.
Lyons, F. L., asst. supervisor, Northrop Aircraft Inc., Hawthorne, Calif.
Marley, G. W., supervising engr., Commonwealth Edison Co., Chicago, Ill.
Martin, L. F., project engr., Union Electric Co. of Missouri, St. Louis, Mo.
Moore, S. E., design engr., Philadelphia Electric Co., Philadelphia, Pa.
Newton, E. C., manager, General Electric Co., Waterbury, Conn.
Peck, D. S., member of technical staff, Bell Telephone Laboratories, Allentown, Pa.
Perris, L., supervising elec. designer, United Engineers & Constructors, Inc., Philadelphia, Pa.
Perry, R. H., electrical testing supervisor, Cleveland Electric Illuminating Co., Cleveland, Ohio
Ralph, E. A., elec. engr., Clark Controller Co., Cleveland, Ohio
Reese, F. D., equipment engg. supervisor, General Telephone Co. of Pennsylvania, Erie, Pa.
Robuck, J. B., substation engr., Texas Power & Light Co., Dallas, Tex.
Schippel, W. H., assoc. prof., McGill Univ., Montreal, Quebec, Canada
Short, H. A., elec. engr., Civil Aeronautics Administration, Seattle, Wash.
Snyder, R. W., asst. div. engr., General Electric Co., Fort Wayne, Ind.
Stalzer, T. R., elec. engr., Sverdrup & Parcel, Inc., St. Louis, Mo.
Syllaasen, O. T., supt. inside construction, lighting dept., City of Seattle, Wash.
Ward-Brown, G., assoc. electrical engr., lighting dept., City of Seattle, Wash.
Wasson, L. C., director, project dept., A. O. Smith Corp., Milwaukee, Wis.
Wheeler, L. E., assoc. elec. engr., lighting dept., City of Seattle, Wash.
Widrig, T. M., district sales mgr., General Electric Co., Seattle, Wash.
Wiegandt, K. M., senior engr., Pennsylvania Power & Light Co., Allentown, Pa.
Wiener, B. S., asst. electrical engr., Public Service Commission, State of New York, 233 Broadway, New York, N. Y.
Wood, R., product section engr., Line Material Co., South Milwaukee, Wis.

53 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership, in the grades of Fellow and Member, have been received from the following candidates, and any member objecting to election should supply a signed statement to the Secretary before September 25, 1952, or November 25, 1952, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Chakrabartty, D. N., College of Engg. & Tech., Calcutta, India
Hawthorne, J. A., Canadian Westinghouse Co., Ltd., Hamilton, Ontario, Canada
Kilby, D. W., English Elec. Export & Trading Co., Ltd., New York, N. Y.
Liversidge, R. P., Philadelphia Electric Co., Philadelphia, Pa.
Maycock, J. H., The Hong Kong Elec. Co., Ltd., Hong Kong, China
Rogers, F. D., New Brunswick Electric Power Comm., Fredericton, New Brunswick, Canada
Sambasivan, R., West Coast Elec. Supply Corp., Ltd., Kallel, Kozhikode, South India
Wendt, K. R., Sylvania Elec. Prod., Inc., Buffalo, N. Y.

8 to grade of Member.

Highlights of the Board of Directors' Report

To summarize some of the highlights in the report of the Board of Directors for the fiscal year ending April 30, 1952, a glance has been taken back over the years to 1942. During that 10-year interval, the growth of the Institute and the expansion of its activities have been phenomenal. The membership has more than doubled, the number of committees and subcommittees has been increased more than threefold. The number of Sections has grown from 72 to 95, with 50 Subsections, and the number of Branches has expanded from 124 to 132, 81 of which are Joint AIEE–Institute of Radio Engineers Branches. The attendance at meetings was greater than ever before and more than twice as many papers are now being published. President McMillan analyzed this growth and described other important Institute activities in an address entitled "Our Achievements," published in *Electrical Engineering* for August 1952, pages 677–80.

The increase in the number of members for each year since the founding of the Institute in 1884 is shown in Figure 1. From 1926 to 1932, the number of members remained fairly constant, then dropped to a low as a result of the depression in 1935 from which it climbed back rapidly and has been gaining at an accelerated rate ever since. The increase during the past year of 4,162 members was the largest gain on record.

After the war, the number of Student members increased rapidly to a peak of 20,668 at the end of the fiscal year in 1950, and then declined rapidly to 8,857 as of April 30, 1952. The decline corresponds with the lowered enrollments in colleges, and particularly in the engineering colleges. Other societies which have student members have experienced similar losses. As over 50 per cent of the new applications for membership result from the transfer of Student members, appropriate steps by means of a card system have been taken to maintain contact with all students after graduation.

The Board of Directors at a meeting held in Asheville, N. C., in May 1946, authorized the organization of additional technical committees as might be needed to cover the important items of electrical technology grouped in appropriate divisions. Partially as a result of this authorization, and partially due to normal growth, the number of technical committees and subcommittees has increased from 85 in 1942 to 298 in 1952, organized in five divisions. The number of technical committees has increased from 18 to a total of 39 and the number of subcommittees has increased from 44 to 218, as illustrated in Figure 2. The effects of the enlarged technical committee organization and operation on a divisional basis has resulted in a marked increase in the number of published papers and in particular in the number of conference papers produced beginning in 1946 as shown in the graphs of Figures 4 and 5. From 1946 until the present, the number of *Transactions* papers increased from 159 to 311 and the number of ACO papers increased from 15 to 62. The number of conference papers rose from 37 to 348 and the District papers also increased from 27 to 95.

While the technical organization was being enlarged, the Sections Committee was busy increasing activities within the Sections through the establishment of Subsections, the holding of more technical group meetings, and the sponsoring of courses, which took place at a greatly accelerated rate during the '40's. This increased activity, combined with the interest immediately following the war, brought about a steady increase in the attendance at Section meetings from a total of 66,111 in 1943 to a peak of 155,649 in 1947, as shown in Figure 3. The increase in the number of Sections from a total of 72 in 1942 to a total of 95 with 50 Subsections in 1952 is shown in Figure 2.

The attendance at each of the four General meetings held within the last fiscal year established an all-time record over the previous maximum attendance for each of the corresponding General meetings. The graphs of Figure 3 show the total attendance at Section, Student Branch, General, and District meetings over the past 11 years. The steady increase in the total attendance at the special technical conferences established in 1948 to a total of 4,256 for the 12 conferences held during the past year is of especial significance. These conferences, technical in character, and concentrated as to subject matter toward one particular industry or objective, fill a definite need for specialists to discuss mutual problems.

The number of papers presented each year in each of the four classes, namely, *Transactions* papers, ACO papers, conference papers, and District papers, is shown in Figure 4. The first 3 years of the war may be considered as normal although it was a period of arrested growth with respect to the number of papers. In the year 1945 there was a considerable increase in the number of published papers due to the many electrical applications to aircraft. The effects of the ban on conventions in 1945 are not reflected until 1946 as

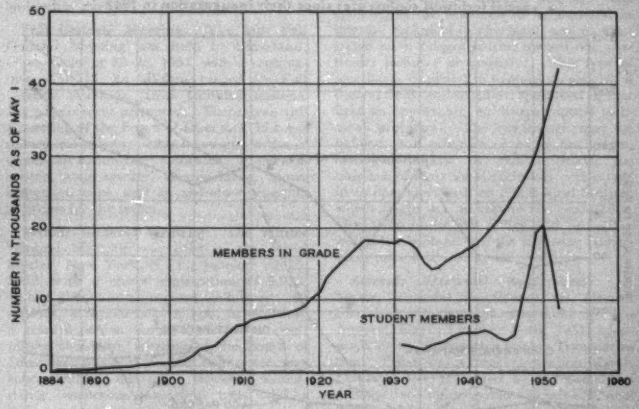


Figure 1 (above). Growth of the membership since the founding of the Institute and the increase and decline of the Student members

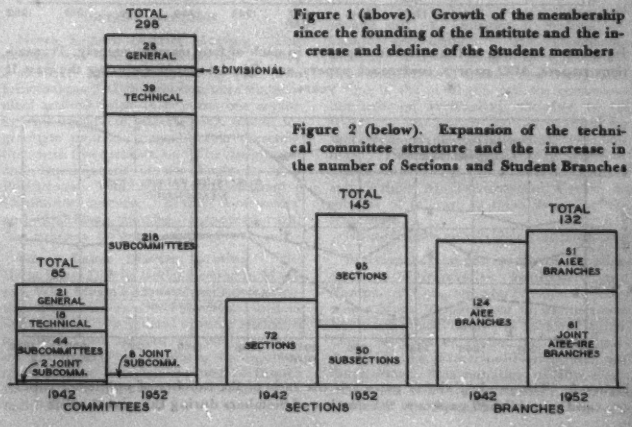


Figure 2 (below). Expansion of the technical committee structure and the increase in the number of Sections and Student Branches

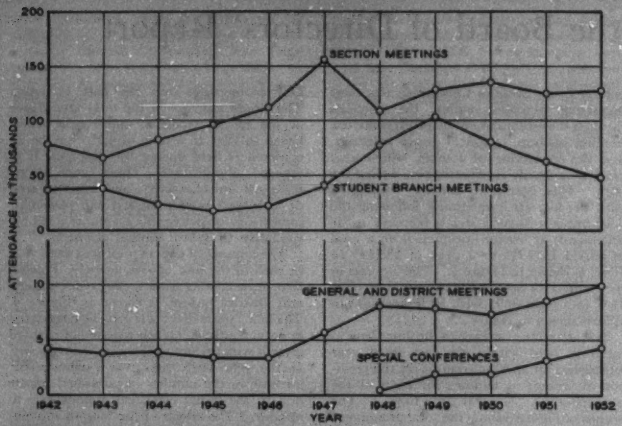


Figure 3. Total attendance at Section meetings, Student Branch meetings, national meetings, and District meetings during the past 11 years, and the total attendance at special technical conferences since their inauguration in 1948

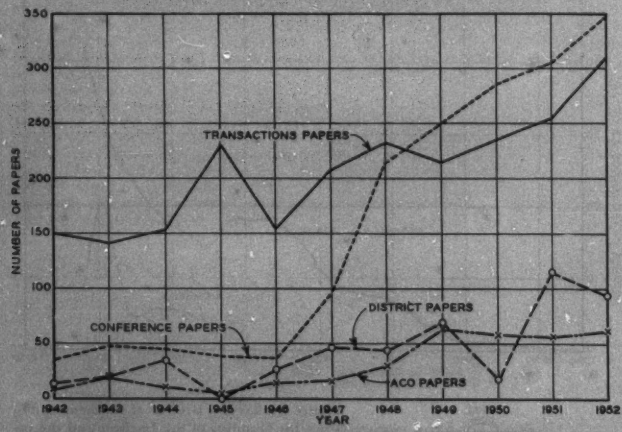


Figure 4. Increase in the number of papers in each of four classes—namely, Transactions papers, ACO papers, conference papers, and District papers—during the past 11 years

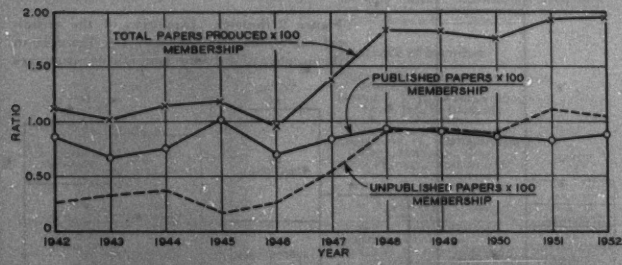


Figure 5. The productivity of papers or the ratio of the number of published papers and unpublished papers to the number of members during the past 11 years

the data in the reports are on the basis of the fiscal years ending on April 30. Furthermore, the ban on conventions was partly offset by a spring, summer, and fall program when papers were sent out for discussion by mail. Beginning in 1946 up to the present under the stimulus of the expanded technical committee structure, the number of published papers increased by more than twofold and the number of conference papers increased by ninefold.

By considering the *Transactions* papers and ACO papers as published papers and the conference papers and District papers as unpublished papers, and the total papers produced each year in all four classes in proportion to the membership growth, an interesting set of graphs result as shown in Figure 5. The increase in the number of published papers has remained proportional to the increase in the number of members. But the ratio of unpublished papers has increased a little over four times and the ratio of the total papers produced in all four classes has increased from 1.12 to 1.94.

The Board of Directors on January 24, 1952, approved a plan for three new bimonthly publications on an annual subscription basis to take the place of the AIEE *Proceedings*. The new publications are as follows:

Communication and Electronics
Applications and Industry
Power Apparatus and Systems

The plan was developed after a careful analysis of a questionnaire which was sent to the membership. More than 19,000 replies to the questionnaire were received; 67½ per cent were in favor of divisional publications on an annual subscription basis as compared with 25 per cent who favored the then existing *Proceedings*. Changes also will be made in the *Transactions* so that they will be issued annually in three parts corresponding with each of the bimonthly publications.

During the interval, important amendments to the Constitution in respect to membership were enacted. For the Fellow grade, membership is by invitation only. The requirements for Member grade also were strengthened. The new Affiliate grade of nonvoting membership was established with all other rights and privileges except the holding of offices reserved to Fellows and Members. These changes were made to conform to Engineers' Council for Professional Development recommendations on uniform grades of membership.

During the past year, the Board of Directors, on January 24, 1952, approved additional constitutional amendments which subsequently were enacted by membership ballot. These amendments permit the granting of credit toward the Fellow grade for membership in an electrical engineering society in any country, permit direct admission to Member grade of members in equivalent grades in cognate engineering societies in any country, clarify the requirements for Member and Associate Member grades, and specify the references required for Fellow grade.

ACKNOWLEDGMENT

The editor gratefully acknowledges the assistance of Vice-President M. D. Hooven and others for their ideas and suggestions which have been incorporated in the graphs and in this summary.

Report of the Board of Directors

THE BOARD OF DIRECTORS of the American Institute of Electrical Engineers presents to the membership its 68th annual report, covering the fiscal year ending April 30, 1952. It contains a brief summary of the principal activities of the Institute during the year, a general balance sheet showing the financial condition of the Institute at the close of the fiscal year, a statement of cash receipts and disbursements, and a schedule of securities owned. Much additional information regarding the activities appeared in various issues of *Electrical Engineering*.

BOARD OF DIRECTORS' MEETINGS

Five meetings of the Board of Directors were held during the year, one in New York, N. Y., and one each in Toronto, Ontario, Canada; Portland, Oreg.; Cleveland, Ohio; and St. Louis, Mo.

Information regarding many of the more important matters which were considered by the Board of Directors appeared in various issues of *Electrical Engineering*.

ANNUAL MEETING

The 67th annual business meeting of the Institute was held in Toronto, Ontario, Canada, June 25, 1951. A brief abstract of the annual report of the Board of Directors for the fiscal year ended April 30, 1951, was presented by Secretary H. H. Henline. Treasurer W. I. Slichter presented a brief report on Institute finances.

President T. G. LeClair explained the proposed amendments to the Constitution upon which the membership had voted recently, and Secretary Henline read the report of the Committee of Tellers on the results of the vote. All proposed amendments were declared adopted.

The report of the Committee of Tellers on the vote of the membership on the election of officers whose terms were to begin on August 1, 1951, was presented by Secretary Henline. President LeClair presented a President's badge to Professor F. O. McMillan, who responded as President-elect by thanking the members for their confidence in him, and giving a brief address outlining some of his objectives.

The Lamme Medal for 1950 was presented to Donald I. Bohn, chief electrical engineer, the Aluminum Company of America, Pittsburgh, Pa.

President LeClair's address on "The Power to Progress" concluded the session.

GENERAL MEETINGS

Four general meetings were held during the year, and a brief report on each follows:

Summer General Meeting. The 67th Summer General Meeting was held in Toronto, Ontario, Canada, June 25–29, 1951, with a registration of 1,851, an all-time record for summer meetings.

There were 38 technical sessions with nearly 170 papers presented, a management session with two papers, a session at which the prize-winning Student papers in the five odd-numbered Districts were presented, a Section Delegates conference, meeting of the Board of Directors, forum of technical committee chairmen, meetings of many committees, numerous attractive inspection trips, President's reception and dance, a dinner-dance, various entertainment events, and many events for the ladies.

Pacific General Meeting. The Pacific General Meeting was held in Portland, Oreg., August 20–23, 1951, with an all-time record registration for Pacific meetings of 887.

The program included a general opening session, 19 technical sessions at which 86 papers were presented, two student technical sessions, a meeting of the Board of Directors, meetings of Branch Counselors and Chairmen, a luncheon in honor of President McMillan, a President's Reception, a banquet and dance, numerous inspection trips, and ladies' events.

Fall General Meeting. The fifth Fall General Meeting was held in Cleveland, Ohio, October 22–26, 1951, with a registration of 1,714, an all-time record for Fall General Meetings. In 37 technical sessions, 151 papers were presented. There were also a meeting of the Board of Directors, 35 committee and subcommittee meetings, forum of technical committee chairmen, a general session, stag smoker, dinner-dance, many inspection trips, and an elaborate schedule of events for the ladies.

Winter General Meeting. The Winter General Meeting was held in the Hotel Statler, New York, N. Y., January 21–25, 1952, with a record registration of 3,925. It had the largest program in history: 69 sessions, with 280 papers, and, in addition, a general session, forum of technical committee chairmen, meeting of the Board of Directors, more than 100 committee and subcommittee meetings, smoker, dinner-dance, numerous inspection trips, and a varied program for the ladies.

DISTRICT MEETINGS

North Eastern District Meeting. This meeting was held in Syracuse, N. Y., May 2–4, 1951. The registration was 340. The principal parts of the program were six technical sessions, with 21 papers; one session for undergraduate papers; one session for graduate papers; a round-table presentation, with five speakers, on "The Assignment and Development of the Engineer as a Professional Man"; a District Executive Committee meeting; Branch Counselors' and Chairmen's meeting; inspection trips; stag smoker; banquet; and ladies' events.

Great Lakes District Meeting. The Great Lakes District held a meeting in Madison, Wis., May 17–19, 1951, with a registration of 626. There were 14 technical sessions with 64 papers, a general opening session, a luncheon, two sessions of undergraduate student papers, one graduate session, banquet, student banquet, meeting of Branch Counselors and Chairmen, inspection trips, and ladies' events.

South West District Meeting. A South West District Meeting was held in St. Louis, Mo., April 15–17, with a registration of 570. In 14 technical sessions, 62 papers were presented. In addition, there were a general session, a session on engineering education, luncheon, smoker, dinner-dance, inspection trips, and ladies' events. Students were invited to attend, and their sessions were held at Washington University all day on April 18, and during the forenoon of April 19. The Branch Counselors and Chairmen held luncheon meetings on the 18th, and a banquet, with presentation of awards, was held at noon on the 19th.

SPECIAL TECHNICAL CONFERENCES

"Special Technical Conferences" were inaugurated in 1948, and have proved so successful that they are now planned and conducted as a regular Institute activity. The conferences are intended to be national in interest, technical in character, and concentrated as to subject matter toward one particular industry or objective. This type of meeting is designed to explore thoroughly a limited field, and to afford specialists in that field an opportunity to discuss mutual technical problems. The conference may be defined as a program of panel discussions, technical papers, or exhibits under the auspices of a national technical committee, in co-operation with an AIEE local Section, which might act as host to the conference. Operating under the policy and procedure which has been set up, the following conferences were held during the year:

Aircraft Electrical Applications. A highly successful Conference on Aircraft Electrical Applications was held in Los Angeles, Calif., October 8–10, 1951, sponsored by the Committee on Air Transportation. There was a total registration of 341. Displays were presented by the Society of Automotive Engineers and Aircraft Electrical Society in Los Angeles.

Twenty-seven papers were presented at six sessions on: 1. Distribution Systems; 2. Control and Cable; 3. A-C Generating Systems; 4. D-C Generating Systems; 5. Environment; and 6. Load and Equipment.

One of the highlights was the conference luncheon on Wednesday, October 10, at which the past history and objectives of the Committee on Air Transportation were outlined. Principal addresses were given by representatives of the Bureau of Aeronautics and Wright Air Development Center on subjects of interest to those attending the conference.

No conference proceedings were published.

Fractional-Horsepower Motor Applications to Refrigeration Equipment and Pumps. A Conference on Fractional-Horsepower Motor Applications to Refrigeration Equipment and Pumps was held in Dayton, Ohio, on October 11 and 12, 1951, sponsored by the Fractional-Horsepower and Single-Phase Subcommittee of the Committee on Rotating Machinery, and the Domestic Appliance Subcommittee of the

Committee on Domestic and Commercial Applications, with the Dayton Section acting as host.

There were four sessions, at which 11 papers were presented, including papers on application of motors to household refrigeration compressors; fiber glass in the wire and cable industry; application of motors to jet-type pumps; fractional-horsepower motor application to sump pumps for domestic service; and many other subjects of interest. On Thursday evening, October 11, there was an inspection tour of the Frigidaire Division of General Motors, Plant Number 2, Moraine City.

Attendance at the conference was 156. No proceedings were published.

Machine Tools Conference. The fourth annual Conference on Machine Tools was held in Rockford, Ill., November 14–16, 1951, sponsored by the Subcommittee on Machine Tools of the Committee on General Industry Applications, in co-operation with the Rock River Valley Section. The total attendance was 476. Eleven papers were presented during the conference; three on the first day, four on the second, and four on the third. The program contained condensed abstracts of the papers presented. One of the highlights of the conference was a talk given by the editor of the *American Machinist* on "Machine Tools—The Next 10 Years."

On Thursday afternoon, November 15, a luncheon meeting of the Subcommittee on Machine Tools was held. The subcommittee unanimously considered the conference very successful, and made plans for holding future conferences on this subject. The next is to be held in Schenectady, N. Y., in the fall of 1952.

The final day of the conference was spent visiting the following plants: Barber-Colman Company, Barnes Drill Company, Greenlee Brothers and Company, The Ingersoll Milling Machine Company, Mattison Machine Tool Company, Rockford Machine Tool Company, Rockford Ordnance Plant, and Sundstrand Machine Tool Company.

No conference proceedings were published.

Feedback Control Systems Conference. A Conference on Feedback Control Systems, sponsored by the AIEE Committee on Feedback Control Systems, was held at Atlantic City, N. J., December 6–7, 1951. A total of 472 engineers, physicists, and mathematicians attended sessions at the Chalfonte-Haddon Hall Hotel.

Some of the papers presented theoretical concepts such as the application of statistical concepts to servomechanism design and the application of frequency response characteristics to the analysis of nonlinear and sample data control systems. Reports on practical problems such as the design and use of precision potentiometers, electromatic resolvers, and electronic amplifiers for instrument servomechanisms were presented. A significant contribution was the discussion of a combination digital and analogue automatic control system being designed for precision control of machine tools. One session was devoted entirely to the problems of control systems including human operators.

The program contained abstracts of all papers presented. No conference proceedings were published.

Computer Conference. A Conference on Computers, jointly sponsored by the AIEE Committee on Computing Devices and the Committee on Electronic Computers of the Institute of Radio Engineers, with the participation of the Association for Computing Machinery, was held December 10–12, 1951, in Philadelphia, Pa. More than 900 engineers, scientists, and mathematicians attended.

There were six full sessions, including one evening session. The subjects at these sessions included: "The UNIVAC System"; "Performance of the Census UNIVAC System"; "The Burroughs Laboratory Computer"; "The Significance of Electronic Computers to Science and Management"; "IBM Card-Programmed Calculator"; "The ORDVAC"; "Experience in Operating the SWAC"; "The ERA 1101 Computer"; "The Operation of the MARK III Calculator"; "The University of Manchester Computing Machine"; "Whirland I Computer"; "The Edsac Computer"; and "The National Bureau of Standards Eastern Automatic Computer."

There were inspection trips to the Bureau of Census UNIVAC at Eckert-Mauchly Division of Remington Rand, Technitrol Engineering Company, Burroughs Research Division, and the Moore School of Electrical Engineering, University of Pennsylvania.

A complete report of the conference, including papers and discussions, has been prepared and is available at $3.50 per copy.

Electronic Instrumentation and Nucleonics in Medicine Conference. Approximately 240 members and guests attended the fourth annual Conference on Electronic Instrumentation and Nucleonics in Medicine, sponsored by the Committee on Electrical Techniques in Medicine and Biology, which was held in New York, N. Y., on January 7 and 8, 1952.

This series of sessions stressed the medical phases of the subject more than heretofore, and the papers presented were of a very high grade. The first day of the conference was devoted to nucleonic applications to medicine, including X rays, gamma rays, and tracers. Electric circuit theory in the study of the circulatory and respiratory systems, and electronic techniques in anesthesia were discussed on the second day.

The highlight of the conference was a demonstration lecture on "Television in Medicine and Biology." The television screen showed what is usually seen through a microscope, and how ultraviolet rays are used to great advantage in medical microscopy.

No conference proceedings were published, but a copy of the abstracts of papers was given to each registrant. A few copies of the abstracts are still available.

Scintillation Counter Conference. Over 400 attended the successful Scintillation Counter Conference, sponsored jointly by the AIEE, Institute of Radio Engineers (IRE), Atomic Energy Commission, and National Bureau of Standards, and held in Washington, D. C., January 29 and 30, 1952.

Sixteen papers were presented in the four sessions. Abstracts of all papers were contained in the program. The subjects included "Two New Photomultipliers for Scintillation Counting"; "Scintillation Spectrometry"; "Pulse-Amplitude Analyzers for Spectrometry"; and others.

The local Sections of the AIEE and IRE, in special consideration of this conference, arranged for a member of the United States Atomic Energy Commission to address a joint session of their Sections and the Scintillation Counter Conference at an evening meeting on Tuesday, January 29. The topic of the talk was "The Reactor Program of the Atomic Energy Commission."

No conference proceedings were published.

Induction and Dielectric Heating Conference. The Cleveland Section was host to the Induction and Dielectric Heating Conference in Cleveland, Ohio, February 19–20, 1952, sponsored by the Subcommittee on Induction and Dielectric Heating of the Committee on Electric Heating.

A total of 338 members and guests registered, including 98 members and 240 nonmembers. The program included 13 papers and an open forum discussion with customer problems answered by a board of seven experts. The papers covered transmission lines for induction heating; the problem of radio interference from such equipment and its control; choice of frequencies for induction heating; dielectric heating in the rubber industry; 60-cycle induction heating; dielectric core baking; electrical codes and standards; and design of mechanisms for induction and dielectric heating.

At an evening session, a representative of the Federal Commications Commission discussed interference problems with other communication services and new regulations, to become effective July 1, covering certification of high-frequency heating equipment.

No conference proceedings were published, but brief abstracts of the papers presented were included in the program.

Conference on Electric Welding. The third Conference on Electric Welding was held in the Rackham Memorial Building, in Detroit, Mich., April 16–18, 1952, sponsored by the Committee on Electric Welding, in co-operation with the Michigan Section, the American Welding Society, and the Industrial Electrical Engineers' Society. Over 500 attended the conference.

The program included 26 papers presented in seven sessions, and there were two evening sessions for the demonstration of electric welding techniques and equipment. The papers dealt with quality control, instrumentation, power supply for resistance welding machines, resistance welding, fundamental arc research, and arc welding. It is planned to publish all papers and discussion in a report of the conference. The better papers will be sent to reviewers, and those which qualify will be recommended for publication in AIEE *Transactions*.

Fourth Conference on Electrical Engineering Problems in the Rubber and Plastics Industries. A very enthusiastic reception was accorded the program presented by the Rubber and Plastics Subcommittee of the Committee on General Industry Applications, April 28, in the Portage Hotel, Akron, Ohio. Attendance at the meeting was 178, with nearly all present for a luncheon.

Eight exceptionally interesting papers were presented on subjects including rectifiers, adjustable voltage drives, electronic controls, and magnetic amplifiers. A beta-ray thickness gauge was described, and one

paper dealt with a complete rubber calender train installation.

Complete proceedings of the meeting will be published in booklet form.

Textile Industry Conferences. Two Conferences on the Textile Industry were held; one at the Philadelphia Textile Institute, Germantown, Pa., on April 24, 1952, at which five papers were presented at the two sessions. "Textile Processing—Toward a Science" was the theme of the conference, which was attended by about 80 members and guests. A luncheon was held, where a representative of the American Viscose Corporation spoke on "The Swift Progress in the Textile Industry." At the conclusion of the last paper, a discussion was conducted on "Textile Motor-Control Enclosures for Lint Atmospheres." This conference was sponsored by the Textile Subcommittee of the Committee on General Industry Applications, the Philadelphia Textile Institute, and the AIEE Philadelphia Section acted as host.

The second conference was held in Atlanta, Ga., at the A. French Textile School, on May 1 and 2. The program consisted of three general themes: 1. Textile Mill Vibration and Control; 2. The Electrical Industry's Application of Equipment to the Textile Industry; and 3. The Textile Industry's Adaptation of the Electrical Industry's Products. The registration was approximately 175. The president of Georgia Institute of Technology welcomed the members and gave an interesting résumé of the efforts and accomplishments of that institution.

Nine papers were presented at the three sessions, with a "Discussion on Desired Characteristics of Industrial Enclosures for Textile Mills," after which a ballot was taken (at both conferences) with the audience participating and casting their votes for the most preferable type of enclosure to meet conditions imposed by the textile industry. The results of this ballot will be presented to the National Electrical Manufacturers Association-AIEE Joint Committee for the purpose of developing a suitable enclosure for such purposes. The second conference was jointly sponsored by the Textile Subcommittee of the AIEE, the A. French Textile School, and the School of Electrical Engineering, through the Engineering Extension Division, Georgia Institute of Technology, Atlanta. No proceedings are to be published.

GENERAL COMMITTEES

BOARD OF EXAMINERS

Attendance at meetings of the Board of Examiners for the year 1951–52 was such that no meetings other than those regularly scheduled were required. The amendments to the Constitution regarding the grades of membership have required a revision of procedure and the formulation of standards to effect a uniform approach for the guidance of the members of the Board in their consideration of applications for admission and transfer. An entirely new approach is required by the Board of Examiners and by those preparing a proposal that a Member receive the grade of Fellow. The Member on whom the grade of Fellow is to be conferred must have engineering accomplishments of such outstanding merit that they are known and acknowledged as such by Members and Fellows other than his immediate associates. The Board is preparing a memorandum on this subject which will be forwarded to sponsors who wish to propose a Member for Fellow grade.

Statistics relating to the number of cases handled by the Board are given in Tables I and II. The total, excluding those enrolled as Student members, is about 1.4 per cent less than in 1950–51. This is apparently due to the drop in the number of engineering graduates and to the stiffening of the requirements for the grades of membership.

The enrollment of Student members is more than 38 per cent less than in 1950–51. The "GI Bill of Rights" for World War II veterans has ended, and this accounts for the drop. The extension of this privilege to Korean veterans and others in the armed services and stress being laid upon the shortage of engineers may reverse this downward trend.

Table I. Applications Received Prior to Amendment of the Constitution

Admission		
Recommended for grade of Associate	2,754	
Re-elected to grade of Associate	27	
Not recommended	36	2,817
Recommended for grade of Member	195	
Re-elected to grade of Member	12	
Not recommended	55	262
Recommended for grade of Fellow		
Re-elected to grade of Fellow		
Not recommended	1	1
Total admission cases		3,080
Transfer		
Recommended for grade of Member	420	
Not recommended	23	443
Recommended for grade of Fellow	102	
Not recommended	6	108
Total transfer cases		551
Total cases		3,631

Table II. Applications and Proposals Received Subsequent to Amendment of the Constitution

Admission		
Recommended for grade of Affiliate		112
Recommended for grade of Associate Member	1,734	
Re-elected to grade of Associate Member	76	
Not recommended	22	1,832
Recommended for grade of Member	2	
Re-elected to grade of Member	6	
Not recommended	1	9
Total admission cases		1,953
Transfer		
Recommended for grade of Member	212	
Not recommended	21	
Total transfer cases		233
Proposals to Have Fellow Grade Conferred		
Recommended for grade of Fellow with citation	5	
Not recommended		
Total for Fellow grade		5
Total cases		2,191
Summation		
Total cases Table I and Table II		5,822
Student member enrollment		3,062
Grand total		8,884

COMMITTEE ON CODE OF PRINCIPLES OF PROFESSIONAL CONDUCT

The "Statement of Principles of Professional Conduct," adopted August 4, 1950, was published in the Year Book for 1950 and 1951, and in the February 1950 issue of *Electrical Engineering*.

During the past fiscal year, no complaints about engineers committing breaches of the Statement of Principles have been made. The committee thus assumes engineers have as individuals observed the code. However, the retiring chairman of the committee calls to the attention of the 1952–53 committee the fact that though engineers individually are observing the code, they may be developing a carelessness in applying it to their performances as organization executives. Reference is made to the extravagant way in which some organizations in their quest for much-needed engineers are visiting areas occupied by other industries, and, by offers of large salary increases, "highjacking" engineers to such an extent as to seriously cripple the work of the company or college whose men are thus induced to leave.

While engineers should be free to choose employment as desired, and should be well-paid for engineering service, there should be some recognized procedures for enticing men from one industry to another. The better professional way to cure the evil will be, of course, by education rather than by legislation, formal or ethical, but before a program of education can be established there must be an adequate course content and proper procedure developed. The formation of such a plan is recommended to the new committee.

COMMITTEE ON CONSTITUTION AND BYLAWS

This committee has prepared and submitted to the Board of Directors Constitution and Bylaws changes required by changes made in the Institute operation over the past year.

Constitution. The Board of Examiners recommendations relating to membership requirements were accepted January 24, 1952, and the Secretary was instructed to submit them to the Institute membership by ballot.

Eight amendments were presented to the membership for adoption.

The first five proposed amendments permit the granting of credit toward the Fellow grade for membership in an electrical engineering society in any country, permit direct admission to Member grade of members in equivalent grade in cognate engineering societies in any country, clarify the requirements for Member and Associate Member grades, and specify the references required for Fellow grade.

Proposed Amendment Number 6 defers until February 15 (instead of February 1) the last date for receipt of amendments proposed by petition, or adoption of a resolution by the Board of Directors proposing amendments. This is desirable because of the possibility that the Winter General Meeting might be held early in February, and it is customary for the Board of Directors to meet during that meeting.

Proposed Amendment Number 7 provides that votes on Constitutional amendments may be received not later than the first day of June (instead of May), as more time is

needed for return of ballots from distant points.

Proposed Amendment Number 8, deferring the date on which amendments become effective to 60 days after adoption (instead of 30), would provide time for notification of the members through *Electrical Engineering* before the effective date.

Bylaws.

Admission to Fellow Grade. The change in the Constitution covering Fellow grade required a change in the Bylaws eliminating the transfer fee, Section 12. A Bylaws change eliminating this fee was made and approved by the Board of Directors.

Delinquent Members. A change in Section 16 relating to delinquent members was considered necessary by the Board of Directors. Section 16 was amended to provide that the Secretary submit a list of delinquents at the first Board of Directors meeting in the fiscal year.

Divisional Operation. Divisional operation of technical activities was approved at the January 24th meeting. The Committee on Planning and Co-ordination recommended a Committee on Technical Operations to combine the activities of the Technical Program Committee and the Technical Advisory Committee. This Committee would have technical cognizance over the technical operations, which would be carried out in five divisions: Communication; General Applications; Industry; Power; and Science and Electronics.

The existing technical committees were assigned to respective division committees in the order of their interest. The Committee on Constitution and Bylaws prepared amendments covering changes in the committee names and redefinition of their scopes. The amendments were approved by the Board of Directors, and will be incorporated in the next printing of the Bylaws.

Publication. The new Institute publication policy was approved at the January 24, 1952, Directors' meeting, and the Committee on Constitution and Bylaws has been instructed to prepare amendments to cover this new policy. These amendments are now in the process of preparation.

Ex-Officio Memberships. Ex-officio memberships were not deleted from the Bylaws after approval by the Board of Directors on April 27, 1950, and at the January 24, 1952, meeting, the Committee on Constitution and Bylaws was instructed to make these changes as soon as possible. The committee has written to all general committee chairmen requesting them to furnish the Committee on Constitution and Bylaws with information on committees membership and scopes that would be in keeping with the action of the Board of Directors. The committee plans to have recommendations ready for consideration by the Board of Directors at its June 1952 meeting.

Committee plans for 1952 include completion of the publication Bylaws, deletion of ex-officio membership, and whatever other activity is required by changed Institute operation.

COMMITTEE ON EDUCATION

During the past year, the Committee on Education met twice, at the Summer General Meeting, and at the Winter General Meeting. During the year, one conference session on education was sponsored, this being at the Winter General Meeting, on the subject of "The Objectives of Graduate Engineering Education."

The meeting of the committee in Toronto, Ontario, Canada, was highlighted by a comprehensive report from the subcommittee studying accrediting procedures. This subcommittee had conducted a comprehensive survey among the principal accredited schools of electrical engineering throughout the United States to determine whether some minimum standards of curricular content would be helpful both to the inspecting group of Engineers' Council for Professional Development and to the colleges. The data thus accumulated indicated a wide variation even between schools of unquestioned standards, and clearly pointed up the fact that the variables are so numerous that no minimum standards could be determined without a further study, far too extensive to be undertaken by the subcommittee at this time. The data collected have been turned over to the chairman of the Committee on Engineering Schools of ECPD. The chairman indicated that the data would be of considerable value to his committee as background information in the inspection program.

The committee meeting in New York was highlighted by the adoption of a very timely tentative program for the coming year. It is proposed to hold conference sessions on education at the Fall General Meeting and at the Winter General Meeting. The proposed subject for the Fall General Meeting is opportunities in the electric power engineering field, with emphasis on careers in the electrical utilities. This appears to be particularly timely, both because of the current shortage of electrical engineering graduates and because of the current emphasis on elcctronics rather than power. For the next Winter General Meeting, the proposed subject will cover the desirable and undesirable features of options in electrical engineering curricula. This is a subject receiving much attention from educational administrators, and should prove of value to the large audience available at that meeting.

The committee was well satisfied with the conference session sponsored at the Winter General Meeting in January 1952. The three papers covering specific objectives of electrical engineering education were well received, and constructive discussion from the audience continued at a lively level until the chairman was obliged to terminate the session. It is firmly believed that sessions such as this are an important factor in keeping active constructive thinking among Institute members concerning educational matters.

The committee again this year expresses sincere regret that the Summer General Meeting conflicts directly with the annual meeting of the American Society for Engineering Education. A preponderance of Institute members directly interested in educational matters are thus diverted away from the Summer General Meeting.

FINANCE COMMITTEE

Included in this report are the usual exhibits consisting of the balance sheet and statements of income, expense, and securities owned as of April 30, 1952. The statements are prepared on an accrual basis, and it will be noted that the Operating Fund Reserve was increased during the fiscal year by $36,422. This is a very creditable performance in light of present conditions and is due to the careful administration of the headquarters staff, as well as painstaking work on the part of all committees to insure that the operations of the Institute were conducted in the most efficient and economical manner. It is interesting to compare this year's performance with previous years. Before doing so, however, an adjustment should be made in the figures shown in the annual reports for the two previous years for the following reason.

Air-conditioning equipment at headquarters was installed and paid for during a period comprising portions of the two fiscal years ending in 1950 and 1951 under an appropriation of the Board of Directors which provided that this equipment be charged against the Reserve Capital Fund. For convenience the several payments were taken from the Operating Fund and then, at the close of the fiscal year ending in 1951, the total amount was repaid from the Reserve Capital Fund. These transactions naturally affected the year-end balances in the Operating Fund in 1950 and 1951. If the payments when made had been charged directly to the Reserve Capital Fund, the performance of the Operating Fund would have shown an excess of income over expenditures in both years, amounting to $3,692 for the year ending 1950, and $11,294 for the year ending 1951. These then are the figures which should be compared with the $36,422 excess of income over expenditures in the fiscal year ending 1952.

It will be seen that the trend is definitely in the right direction. However, as emphasized in the report of this committee last year, the recovery that has been made since the 1947–1949 period when we were operating in the red has required certain curtailments in the services to members, and it is considered undesirable to continue these restrictions.

The constitutional amendment which was submitted to the membership in the spring of 1951 was approved, and thereby the dues and entrance and transfer fees were lifted from the Constitution and transferred to the Bylaws. The purpose of this change is to permit an adjustment to be made in the dues and fees, if such should become desirable, without long delay.

HEADQUARTERS COMMITTEE

An inspection of the headquarters' office space in the fall of 1951 found the only necessary items to be those of minor maintenance.

Repairs to furniture in the hall, Members' Room, and Board of Directors' Room, cleaning of draperies, and servicing of the air-conditioning units was included in a $1,000 item in the Institute's budget. To date, only a part of this sum has been expended. It is planned to take care of most of the repair work during the coming summer.

The blistering of the veneer wall covering in the Members' Room and Board of Directors' Room is growing worse, and it would appear that major repairs will be necessary within the next few years.

COMMITTEE ON MEMBERS-FOR-LIFE FUND

Travel expenses to Summer General Meetings have been provided from the Members-

for-Life Fund for some of the winners of Student paper prize contests. The amount available in the fund was not sufficient to meet travel expenses of all winners, so only the winners in the even-numbered Districts received travel expenses from the fund in even years and the winners from the odd-numbered Districts in odd years.

The fund has now grown to some $13,000, with an annual income of approximately $2,500. The committee considers this sufficient to meet the travel expenses of all Student paper prize winners each year. On October 19, 1951, recommendation was made to the Board of Directors that travel expenses for the winners of Student paper prize contests from all Districts be paid from the fund beginning with the 1952 Summer General Meeting. The recommendation was approved.

MEMBERSHIP COMMITTEE

Membership in the Institute increased by 4,162, the largest numerical gain of record. This is a gain of 10.9 per cent, a slight decrease from the last year's figure of 11.3 per cent.

Table III shows the distribution of the membership changes among the various grades. The effect of the added grade of Affiliate has been insignificant.

During the year 5,021 applications were received, of which 2,591 were from Students, and 2,430 from others. The sharp decrease in Student applications results largely from the decrease in Student membership and will continue for several years. The marked increase in applications from other than Students is the result of concentrated membership efforts in that area to compensate for the anticipated reduction in Student applications.

Student membership declined from 15,028 in 1951 to 8,857 this year. This is almost directly proportional to the decline in student enrollments. Efforts are continuing to assist in encouraging a greater percentage of enrolled students to become Student members.

Members in arrears for dues numbered 2,047, or 4.8 per cent, compared with 4.9 per cent reported last year.

The committee is especially appreciative of the co-operation of the Section chairmen in the early formation of Section membership committees this year, and the response of these committees to the appeal for greater effort in the other than Student area, and the gratifying results of their efforts.

COMMITTEE ON PLANNING AND CO-ORDINATION

The committee spent the greatest portion of its time during the past year on the formalization of the technical division activities of the Institute. Operation of the technical committees on a divisional basis was approved by the Board of Directors in 1946 at its Asheville, N. C., meeting. In the period subsequent to that time, this method of operation proved to be successful. There remained only the problem of Bylaws formalization of procedures which had been developed since 1946. After full discussion at several forums of technical committee chairmen, discussions within the various divisions, and extended correspondence, the committee presented to the Board of Directors a set of recommendations which included the merging of the Technical Program Committee and the Technical Advisory Committee into the Committee on Technical Operations, as well as the formalization of the divisional setup. The recommendations were adopted and the necessary Bylaws changes made.

COMMITTEE ON AWARD OF INSTITUTE PRIZES

The Committee on Award of Institute Prizes has given much consideration to the existing situation and practices concerning the award of prizes. It is the general opinion in the committee that the present method of selecting prize papers leaves much to be desired, and that the award of prizes on a division basis is not resulting in recognition for many meritorious technical papers. It is also generally thought that the preparation of papers for presentation at qualified technical meetings of the Institute is not done for the purposes of competing for cash prizes, and that to a considerable degree the award of cash prizes for such papers tends to degrade the entire procedure.

At a December meeting of the committee, it was decided that certain recommendations for changes in the procedure should be made to the Committee on Planning and Co-ordination. These changes would abolish the selection of division prize papers and would abolish cash prizes except for the best Student paper. The selection of Institute prize papers would be limited to meritorious initial papers, and Certificates of Award would be presented to authors of papers selected by the Committee on Award of Institute Prizes from nominations made by the division prize awards committees. The recommendations were to the effect that the procedure and prizes for Student, Branch, and District papers should remain as presently set forth in the prize rules. The Committee on Planning and Co-ordination, at its January meeting, approved these changes in

Table III. Membership Statistics for Fiscal Year Ending April 30, 1952

	Honorary Members	Fellows	Members	6-Year Associates	Associates	Affiliates	Subtotals	Total
Membership April 30, 1951	7	1,369	9,798	10,036	16,848			38,058
Additions								
New members qualified			184		5,318	75	5,577	
Former members reinstated or re-elected	1		69	79	148		297	
Subtotals	1		253	79	5,466	75	5,874	
Transfers	161		645	1,652			2,458	
Totals	162		898	1,731	5,466	75	8,332	
Deductions								
Died	1	18	71	70	31		191	
Resigned			64	138	180		382	
Dropped		1	87	423	628		1,139	
Subtotals	1	19	222	631	839		1,712	
Transfers			160	545	1,753		2,458	
Totals	1	19	382	1,176	2,592		4,170	
Net Changes	143		516	555	2,872	75	4,162	
Membership April 30, 1952	6	1,512	10,314	10,591	19,722	75		42,220

Table IV. Number of Applications Received From Student Members and From All Others

Year Ending April 30	Students	All Others	Total
1952	2,591	2,430	5,021
1951	4,168	2,082	6,250
1950	4,033	2,417	6,450
1949	2,286	2,192	4,478
1948	1,481	2,272	3,753
1947	938	2,331	3,269
1946	308	2,453	2,761
1945	249	2,179	2,428
1944	466	1,908	2,374
1943	783	1,431	2,214

Table V. Number of Student Members as of April 30

Year	New Applications	Renewals	Total
1952	3,023	5,834	8,857
1951	4,635	10,393	15,028
1950	7,876	12,792	20,668
1949	9,967	9,461	19,428
1948	7,876	6,041	13,917
1947	5,092	3,929	9,021
1946	2,574	2,513	5,087
1945	2,326	2,287	4,613
1944	2,242	2,656	4,898
1943	2,512	3,200	5,712

Table VI. Record of AIEE Membership

Year	Total May 1	Year	Total May 1	Year	Total May 1
1884	71	1907	4,521	1930	18,003
1885	209	1908	5,674	1931	18,334
1886	250	1909	6,400	1932	18,003
1887	314	1910	6,681	1933	17,010
1889	333	1911	7,117	1934	15,230
1890	427	1912	7,459	1935	14,269
1891	541	1913	7,654	1936	14,600
1892	615	1914	7,876	1937	15,308
1893	673	1915	8,054	1938	16,078
1894	800	1916	8,202	1939	16,605
1895	944	1917	8,710	1940	17,213
1896	1,035	1918	9,282	1941	17,886
1897	1,073	1919	10,352	1942	18,944
1898	1,098	1920	11,345	1943	20,161
1899	1,133	1921	13,215	1944	21,407
1900	1,183	1922	14,263	1945	23,072
1901	1,260	1923	15,298	1946	25,090
1902	1,549	1924	16,455	1947	26,470
1903	2,229	1925	17,319	1948	28,408
1904	3,027	1926	18,158	1949	30,791
1905	3,460	1927	18,344	1950	34,198
1906	3,870	1928	18,265	1951	38,058
		1929	18,133	1952	42,220

principle, and so notified the Board of Directors.

The proposed changes in prize rules were subsequently explained to the forum of technical committee chairmen. An attempt was made to get the sentiment of the forum with respect to these proposed changes. In general, those present were strongly in favor of abolishing the cash prizes. There was, however, evidence of strong sentiment against the abolishment of division prizes, and in favor of retaining awards other than cash for other than initial papers.

It appears, therefore, that considerable thought and time will be required before it is desirable to carry out the changes which were recommended by the committee.

PROFESSIONAL DIVISION ADVISORY COMMITTEE

It was agreed at the January meeting that the Professional Division Advisory Committee should be discontinued as of July 31, 1952. The Board of Directors approved. In the future, such matters as require the action of the associated committees will be handled directly with these committees.

Possible revision of the Model Law relating to the Registration of Engineers is under study by the ECPD and others. In order to assist in formulating the opinion of the AIEE, this subject is currently being investigated through the Committee on Registration of Engineers.

PUBLICATION COMMITTEE

High standards of publication have been maintained by continuing the policy to accept only original material. During the calendar year 1951, the largest number of pages of published material in the history of the Institute, a total of 3,383 pages, was made available. The number exceeds the peak which occurred in 1948 by 11.2 per cent and it is 14 per cent higher than the total number of pages which was published during the year 1950. For ready comparison, the numbers of pages of published material are given in Table VII.

Electrical Engineering. The publication has been planned on the basis of broad interest for the greatest number of members. The distribution of material classified in seven broad fields is shown in Table VIII, which readily may be compared with similar tables in the reports of previous years.

Replies to the Technical Division Publications Questionnaire have been used as criteria for the number of articles to publish in each of the five major divisions of technical activities. Prior to the receipt of returns from the Technical Division Publications Questionnaire, the number of *Proceedings* papers ordered was used to indicate the number of articles to publish in each of these fields. In Table IX is shown a comparison of subject matter in *Electrical Engineering* for the past three years with the primary interests of members as indicated in the Technical Division Publications Questionnaire.

While it has often been said that the AIEE is primarily a power organization, it is interesting to note from Table IX that a higher percentage of articles in the fields of science and electronics, communication, and general applications has been published in these fields than the primary interest indicated in them from the Technical Division Publications Questionnaire. *Electrical Engineering* offers a fast medium of publication for the brief, informative type of article which appeals particularly to those in these fields.

Table X shows how the total pages in *Electrical Engineering* for the year were used for the different classifications of material published.

Advertising. Based on study of the circulations and advertising rates of several other publications, the committee recommended that the advertising rates of *Electrical Engineering* should be increased approximately 16⅔ per cent effective January 1, 1952. The total pages of paid advertising for the year ending April 30, 1952, were 839 compared to 662 for the previous year, which is a 26.8 per cent gain. The total pages for the first 4 months of 1952 since the increased rate has been in effect were 295, as compared with 220 for the same 4 months of the previous year, or a 34.1 per cent gain notwithstanding the increased rate. This indicates a very favorable condition. From his experience on trips, the Advertising Director reported that the publication is highly regarded and that good relations existed on a friendly basis with all advertisers and agencies.

Table VII. Number of Pages of Published Material

Year	Electrical Engineering: Technical Articles	Electrical Engineering: News	Electrical Engineering: Transactions Sections	Transactions Only: Technical Papers	Transactions Only: Discussions	Transactions Only: Total
1941	337	281	600	542	268	2,028
1944	246	214	738	493	231	1,922
1945	253	225	736	121	143	1,480
1946	285	315	832	254	120	1,806
1947	806	474		1,600*	153*	3,033
1948	832	395		1,643†	172†	3,042
1949	796	320		1,275**	167**	2,558
1950	836	323		1,579‡	173‡	2,911
1951	854	321		1,807§	401§	3,383

* Preprinted 227 papers as AIEE *Proceedings*, except for a 17-page technical paper in *Electrical Engineering*.

† Preprinted 247 papers as AIEE *Proceedings*, requiring a total of 2,090 pages.

** Preprinted 202 papers as AIEE *Proceedings*, requiring a total of 1,795 pages.

‡ Preprinted 238 papers as AIEE *Proceedings*, requiring a total of 2,014 pages.

§ Preprinted 317 papers as AIEE *Proceedings*, requiring a total of 2,660 pages.

Table VIII. Classification of Articles in Electrical Engineering in Seven Broad Fields

(Exclusive of 1-Page Digests)

	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	Total
General interest	2		2	3	2	1	4	2	4	3	5		28
Educational	1	1	1						1			1	5
Science and electronics	4	3	4	3	3.5	3	5		3	2	2	3	35.5
Communication	3		1	2	2	3	1	3	1	1	2	1	20
Power	2	4	3	1	3	3	2	7	2	7	5	3	42
Industry	2	2	2	1	1.5	2	2	1	2	1	3	3	20.5
General applications	2	3	1			1	1		1			1	10
Totals	14	13	14	10	12.0	13	15	13	14	14	17	12	161.0

Table IX. Comparison of Subject Matter in Electrical Engineering With Primary Interest of Members Indicated in Technical Divisions Publications Questionnaire

	Primary Interests of Members (Questionnaire)		Technical Articles in Electrical Engineering (Per Cent)		
			Year Ending in April		
	Number	Per Cent	1950	1951	1952
Science and electronics	3,268	16.9	28.4	32.5	27.8
Communication	2,562	13.2	22.7	12.0	15.6
Power	8,537	44.0	31.8	36.0	32.8
Industry	3,231	16.7	11.4	12.0	16.0
General applications	1,405	7.2	5.7	7.5	7.8
None	393	2.0			
Totals	19,396	100.0	100.0	100.0	100.0

Table X. Material in Electrical Engineering, May 1950 to April 1951

	Number of Articles	Number of Pages	Per Cent Pages
Special Articles	45	165	13.4
Technical Papers	67	318	25.9
Conference Papers	50	220	17.9
One-Page Digests	137	137	11.1
Essays	4	4	0.3
Filler Items	54	10	0.8
Institute Activities		211	17.2
Current Interest		80	6.5
Industrial Notes, Trade Literature, and so forth		30	2.4
Proceedings Order Forms		7	0.6
Title and Highlights Pages		24	1.95
1951 Index		24	1.95
		1,230	100.00

Transactions. Volume 70 of the 1951 *Transactions* has been made available in two parts. Part I, which consisted of 1,121 pages, was made available last November, and contained papers from the Winter General Meeting, the spring meetings, and a portion of the papers from the Summer General Meeting. Part II, which consisted of 1,087 pages, contained the papers and discussions from the meetings held during the remainder of the calendar year and it was made available in April.

AIEE Proceedings. During the year there was an increase in the number of *Proceedings* pamphlets ordered. A total of 7,435 orders was received, 682 of which were for the papers of the year preceding. The total number of orders represented a distribution of 76,630 copies. The larger distribution was due to the increased number of papers during the year, which was 317 compared to 238 for the year previous. Most of the copies distributed were for the free allowance and the total cash receipts was only $805.

Divisional Publications. Culminating a 3-year study, the Publication Committee on January 24 recommended to the Board of Directors a plan for divisional publications to take the place of the present *Proceedings*. As announced in *Electrical Engineering* for March 1952, page 279, beginning in July and August three publications will be issued bimonthly as follows:

Communication and Electronics
Applications and Industry
Power Apparatus and Systems

The first two publications listed will begin in July. The *Power Apparatus and Systems* will be issued in August.

Each member will have the option to elect to receive in consideration of payment of dues, without additional charge, one of the three bimonthly publications. Additional publications may be obtained by members at an annual subscription price of $2.50 each. The subscription price to nonmembers is double, or $5.00 each. The new plan for bimonthly publications should provide a more convenient means for members to obtain the technical papers in which they are interested on an annual subscription basis rather than filling out an order form each time it appears in *Electrical Engineering*. Of the members who answered the Technical Division Publications Questionnaire, 67⅓ per cent favored a plan of divisional publications as compared with 25 per cent who were in favor of the present *Proceedings*. Also, a random analysis of 101 orders for *Proceedings* when compared with the answers to the questionnaire indicated that 57 per cent who were ordering *Proceedings* favored the plan of bimonthly publications as compared with 40 per cent who favored the present *Proceedings*. As indicated from the questionnaire, approximately 19,000 different members will make use of the bimonthly publications as compared with 2,000 who now order *Proceedings* a year (over two-thirds of the orders received are from the same individuals). A much broader service will be rendered to the membership. When the time to make out and fill orders is also taken into consideration, the bimonthly publications may render a faster publishing service.

With the introduction of the bimonthly publications, the Publication Committee also recommended that the *Transactions* be issued annually in three corresponding parts.

Part I. Communication and Electronics
Part II. Applications and Industry
Part III. Power Apparatus and Systems

By overprinting the pages of each bimonthly publication for the annual *Transactions*, certain economies in the mechanics of printing will be effected, as well as less spoilage of paper. The annual subscription price to *Transactions* for members has been increased from $5.00 to $6.00 to provide for one additional cloth binding a year when bound in three parts, as well as other increased production and mailing costs. Provision also was made for members to subscribe to any one of the three parts at $3.00 per year.

Special Publications. During the year, the following four special publications have been made available and work on a fifth, "Symposium on Polyethylene," is in progress.

1. Bibliography on Power Capacitors, 1925–1950 (1/52)
2. Review of Electronic Digital Computers* (2/52)
3. Power Supply for Resistance Welding Machines (4/52)
4. Survey of Operation of Mercury Arc Rectifiers (4/52)

In addition, three of the older special publications have been rerun in quantities of 500 to 1,000. Two of these are of a fundamental nature and probably used for classroom work.

1. Interior Wiring Design for Commercial Buildings
2. Mathematics for Engineers
3. Elements of Nucleonics for Engineers

These special publications are on a self-supporting basis and are made available to members at cost and in general to nonmembers at double cost through order forms published in *Electrical Engineering* from time to time.

COMMITTEE ON PUBLIC RELATIONS

A new publicity kit has been prepared and distributed.

A program of greater help to the general and District meetings has been instituted, with the attendance of a representative of Mayer Associates at the meetings. It is most important to understand that the personal attendance of Mr. Mayer's representative is in no sense with the idea of "taking over." The local committee and representatives are still of prime importance, and Mr. Mayer or his men are present to be of whatever help they can. Judging from the letters received, this is working out very well.

The first sample of a periodical publicity newsletter is ready, by means of which it is hoped to spread information on publicity among the Sections. It will be a medium of exchange of ideas.

News releases on papers, members, and personalities have increased and improved. There has been much progress, although much remains to be done in finding the most noteworthy publicity items. The coverage of the technical conferences is also much better, and is continuing to improve.

The committee is also working on a manual to assist and guide publicity chairmen in handling the publicity for their meetings.

The number of Sections having publicity chairmen is steadily increasing. Correspondence indicates a great increase in activity and interest in publicity and public relations on the part of the Sections. Sections should call on Mr. Mayer for any assistance they may desire for their particular problems.

COMMITTEE ON REGISTRATION OF ENGINEERS

The committee has continued its efforts to advise the Institute membership on the problem of registration. Appropriate steps to accomplish this were discussed at the meeting held during the Winter General Meeting. All but two of the committee members were present, and the absent members were both represented and expressed their views by letter.

It was agreed that the committee should assume an active position in matters of registration, and to this purpose a program was devised. A paper prepared by one of the members is currently being reviewed by the committee, so that it may be published in *Electrical Engineering*. Two of the members have been assigned the task of revising a previously published article, in order that it may be available in pamphlet form at headquarters. An effort is being made to set up a list of speakers in various parts of the country who will be available to speak on the subject of registration.

Several months after this meeting, the Institute received a request from the ECPD Committee on Professional Recognition concerning the advisability of revising the Model Law. It was referred to the committee. The opinion resulting from a poll of its members was transmitted to President McMillan for his guidance.

The practice, begun in the 1950 Year Book, whereby registered profession engineers were indicated by a dagger, was continued in the 1951 edition. Some of the membership remains improperly identified in this matter. It is hoped that more will fill out their information cards correctly in the future.

COMMITTEE ON RESEARCH

The Committee on Research met during the Winter General Meeting in New York, N. Y., and considered how it should direct its efforts to further the interests of AIEE. As a result of the discussion, it was agreed that the program to be supported by the committee should be the following:

1. To do those things which would encourage undergraduate and graduate students to enter research work in fields directly concerned with the problems of power generation, transmission, and distribution.
2. To represent AIEE on such agencies as the National Science Foundation and to suggest to such agencies that they give increased support to research-minded graduate and undergraduate students who could be interested in work appropriate to all fields of interest to AIEE, but particularly to the field of power generation, transmission, and distribution.
3. To sponsor at the next Winter General Meeting a talk of a general nature on the subject of research, to be given by an outstanding scientist.
4. To work with the technical committees of the Institute in an effort to promote the

* Conference Report.

presentation of research papers covering material of interest to the particular technical division involved.

In order to implement the foregoing program, the committee has taken steps to establish liaison with the technical committees and also with the Committee on Technical Operations.

COMMITTEE ON SAFETY

In general, the Committee on Safety can report a satisfactory year. Because electrical safety is a problem that is common to most activities of the Institute, the committee has tried to reach out into new activities on an organized Institute-wide basis. To do this, three subcommittees were formed, and a number of new ventures were launched.

Liaison Activity. In response to invitations extended this year, each of the five technical divisions appointed a liaison representative to the Committee on Safety. Each representative works with a teammate from the committee. The basic liaison job is to interest and encourage each of the technical committees in the Institute to: 1. start systematically preplanning into its sessions each year one or more safety papers focused on its own field; 2. produce new safety standards as needed, within its own field; and 3. refer back broad safety matters that should be considered in generic terms by the Committee on Safety for the Institute as a whole.

In addition to stimulating activity in the technical committees, a letter from President McMillan to all Section chairmen suggested a discussion on electrical safety to be included in the program of each Section during the year. A similar letter was sent by F. W. Tatum, chairman of the Committee on Student Branches, to all Student Branches.

Special Projects. From a list of 33 suggested special projects, six were selected and organized. The projects include both short- and long-range objectives and are: 1. safety hazards studied, analyzed, and classified with relation to promoting safety consciousness on the job and in the home; 2. development of field-type defibrillator for ventricular fibrillation from electric shock; 3. informational pamphlet on electric shock with bibliography; 4. improved safety design of pole structures carrying electric circuits; 5. uniform code on electrical safety; 6. ways and means of effective co-operation with other technical groups on electrical safety.

Papers and Meetings. One or more safety sessions were held at each general meeting, and the papers have been interesting and fruitful. Topics discussed include: symposium on domestic, industrial, commercial, and utility safety; *Transactions* paper on new push-pull method of artificial respiration; electrical safety as the Underwriters' Laboratories see it; European electrical safety practice; probable changes in the 1953 National Electrical Code; and a series of progress reports from Dr. Kouwenhoven on his promising pioneering research in electrical defibrillation.

Plans for the future meetings include diversified discussions ranging from best methods for extinguishing electrical fires to electrical safety problems in hospitals. For the 1953 Winter General Meeting, a comprehensive technical forum will be conducted on grounding and leakage currents; and, for the 1953 Summer General Meeting, a symposium will compare the areas of activities of the many organizations that deal with electrical safety.

General. During the year, general policy guidance in the field of safety was extended to the Institute by the following resolution:

Resolved: That the AIEE Committee on Safety endorses the back-pressure arm-lift method and the other push-pull methods of artificial respiration as recently adopted by the American Red Cross, the Armed Services, and others as the preferred general-use methods of artificial respiration. That the pole-top method continue to be recognized as a preferred method of artificial respiration in cases involving persons receiving electric shock while working on poles. That this resolution be submitted to the AIEE Board of Directors with recommendation for favorable consideration and that this matter be called to the attention of members of the Institute through publication in *Electrical Engineering*.

This resolution was approved by the Board of Directors on January 24, 1952, and published in the March 1952 issue of *Electrical Engineering* (*page 283*).

SECTIONS COMMITTEE

Section Activities. Since the last annual report, six new Sections have been organized, which brings the present total to 95. Three of these Sections were approved by the Board of Directors in June 1951, and are now listed in the Year Book.

During the present administrative year, the former Corpus Christi Subsection of the South Texas Section has been organized as the Corpus Christi Section; former Tampa Subsection of the Florida Section has been established as the Tampa Section; and the former Wilmington Division of the Philadelphia Section will become the Delaware Bay Section as of June 1, 1952.

As a result of the establishment of the new Tampa Section, the name of the Florida Section was changed to the Jacksonville Section.

During the present year, the Monroe (La.) Subsection of the Shreveport Section, and the Adirondack Subsection of the Schenectady (N. Y.) Section were organized. Similar organizational studies in other Section areas indicate a good possibility for additional Subsections within the near future.

Interim Meeting. During the Winter General Meeting, the Sections Committee held an informal get-together and interim meeting with attendance by a good representation from the Sections, as well as officers and District Secretaries. Discussions were held on general Institute affairs, such as finances, divisional operation of technical activities, progress report of the Engineers Joint Council Exploratory Group on the formation of a unity organization; and general matters of Section operation and management, such as student guidance, membership, publicity, Student Branches, transfers, growth award plan, and the formation of Subsections and technical discussion groups. Minutes of this meeting were circulated to all Sections for their guidance.

Special Activities. A revision of the bulletin, "Technical Groups," was prepared by a specially appointed subcommittee. Many suggestions based on the experience of successful operation of such groups during the last few years have been incorporated. Copies of the revised bulletin are now available upon request.

Another subcommittee has been tabulating all data necessary for the determination of Section Growth Award winners during the administrative years 1950–51 and 1951–52. The winners of these awards will be announced at the Summer General Meeting, and thereafter all yearly award winners will be determined at the close of the administrative year.

At each of the meetings of the District executive committees, a Sections Committee representative led a discussion of problems concerning the operation and management of Sections, which has been productive of many good results in the broadening of their activities.

In accordance with a suggestion of President F. O. McMillan, the Sections Committee broadcast information regarding the organization of Women's Auxiliaries as a further method of broadening interest and participation.

In view of the great importance of the subject, a special forum program has been organized for presentation during the Summer General Meeting on "The Shortage of Engineers." This program will point up the present situation, the needs and prospects for engineering employment in the future, and present specific suggestions to the Sections for the encouragement of a greater number of science-talented young people to enter the profession of electrical engineering.

With the co-operation of the Committee on Student Branches and the Membership Committee, a plan for the recording of initial employment information immediately following graduation by Student members, was put into effect. All Student Branch Counselors were requested to forward information record cards to headquarters for dissemination to the Sections. This will permit Section

Table XI. Section and Branch Statistics

	For Fiscal Year Ending April 30					
	1947	1948	1949	1950	1951	1952
Sections						
Number of Sections	75	81	84	87	89	95
Number of meetings held	1,333	1,340	1,561	1,605	1,716	1,747
Total attendance	155,649	109,637	128,025	135,847	125,779	128,362
Branches						
Number of Branches	126	127	129	130	132	132
Number of meetings held	1,018	1,172	1,350	1,298	1,281	1,162
Total attendance	40,669	77,040	103,828	80,672	62,630	48,674

membership committees to contact these newly employed Student members immediately after their arrival in local areas to encourage their applications for election as Associate Members and active participation in Section activities.

STANDARDS COMMITTEE

During the year, two meetings were held, and a third meeting is scheduled for June. The meetings have been well-attended by the 26 appointed members and by a number of the liaison representatives.

The development of basic standards has progressed in AIEE since the formation of the first Standards Committee in 1898. In the 1930's, preparation of test codes separate from the standards proper became an important function. It is now noted that there is increasing activity in the preparation of Recommended Practices such as guides for operation, for installation, and for maintenance.

Approved Standards. Since last year's report, the following Institute Standards have been completed or revised:

AIEE *16A*, Electric Control Apparatus for Land Transportation Vehicles.

AIEE *18* (American Standards Association (ASA) *C35.1—1951*), American Standard for Capacitor Units.

AIEE *20* (August 1951), Low-Voltage Air Circuit Breakers, and a proposed test code, for submission to ASA Sectional Committee *C37*.

AIEE *22A*, Air Switches, Insulator Units, and Bus Supports.

AIEE *25*, Fuses Above 600 Volts.

AIEE *27* (January 1952), Switchgear Assemblies and Metal-Enclosed Bus.

AIEE *45* (December 1951), Electric Installations on Shipboard.

AIEE *910*, Recommended Practice for Measurement of Field Intensity Above 300 Megacycles From Radio-Frequency Industrial, Scientific, and Medical Equipments.

ASA *Y32.1.1*, Graphical Symbols for Single- (1-) Line Electrical Engineering Diagrams. (American Society of Mechanical Engineers and AIEE are joint sponsors under ASA procedure).

Proposed revisions in the American Standards for Transformers ASA *C57.11* and Test Code ASA *C57.22*, regarding dielectric tests and measurement of temperature rise, were approved and referred to ASA Sectional Committee *C57*.

Standards With Approval Pending. The following Standards are in process of approval:

Proposed revisions of ASA *C37.4*, Alternating-Current Power Circuit Breakers.

C37.5, Methods for Determining the RMS Value of a Sinusoidal Current Wave and a Normal-Frequency Recovery Voltage.

C37.9, Test Code for Power Circuit Breakers.

These were developed by the Power Circuit Breaker Subcommittee of the AIEE Committee on Switchgear and will be submitted to ASA Sectional Committee *C37*.

A "Guide for Operation and Maintenance of Dry-Type Transformers With Class B Insulation" to be published in report form for comment. This was prepared by the AIEE Committee on Transformers, and eventually will be submitted to ASA Sectional Committee *C57*.

"Recommended Practices for Lightning Protection of Base Stations in the Mobile Radio Service." This was prepared by the Mobile Radio Subcommittee of the AIEE Committee on Radio Communication Systems.

Standards Under Preparation. The Committee on Electronic Power Converters reported that work is being done on a proposed standard for hot-cathode converters and one on rectifier auxiliaries.

The Committee on Protective Devices reported that three guides for grounding of generators, transmission systems, and ground fault neutralizers are under preparation.

The Committee on Instruments and Measurements has prepared a third draft of the Test Code for Power Measurement.

The Committee on Air Transportation is working on altitude rating standards and the possibility of establishing typical curves and the manner of presenting data.

A subcommittee of the Standards Committee has been reconstituted to prepare a revision of the Standards Manual to bring it up to date with respect to changes which have been made in the AIEE Constitution and Bylaws, provision for liaison representatives on the Standards Committee in place of ex-officio members, and to incorporate the balloting guide, which was completed during the year by a subcommittee of the Standards Committee. The purpose of this guide is to instruct Institute committees in desired practices for obtaining a consensus and vote on standards which are to be submitted to the Standards Committee for approval.

This subcommittee also will undertake the preparation of a guide on the form and arrangement of Standards publications.

American Standards Association. The Institute was one of the five societies which founded the American Standards Association in 1918 (then called the American Engineering Standards Committee) as a clearing house for the co-ordination of standardization activities. A number of the Standards originally adopted as AIEE Standards are now revised and approved as American Standards by ASA under sectional committee procedure. AIEE continues to support ASA standardization work and most of the standards which are developed in AIEE committees sooner or later become American Standards.

The Institute serves as sole or joint sponsor for a number of ASA projects. As joint sponsor with NEMA for example, a reorganization of the Sectional Committee on Industrial Control Apparatus was effected during the past year, in preparation for revision of the Standard.

As of October 1951, ASA had approved 1,234 standards, almost 200 of which, coming under 42 different projects, are electrical.

Participation in the work of the International Electrotechnical Commission since 1930 has been carried on under the auspices of ASA by the United States National Committee of IEC. Plans are well advanced for the Fiftieth Anniversary Jubilee Meeting of IEC in the United States in 1954. It may be of interest to some AIEE members that the Institute created the United States National Committee of the IEC in 1906, maintained and appointed it until 1921. The Standards Committee and its working subcommittees for the most part prepared the technical proposals for and jointly with the USNC up to the time of the consolidation of the Electrical Standards Committee and USNC under ASA in 1930.

It is also of interest that the International Organization for Standardization (ISO), which covers the broad field of international standardization, will hold a meeting in New York, N. Y., June 9–21, 1952. Meetings of 11 of the 76 ISO technical committees have been scheduled. United States participation in ISO work is carried out through ASA.

In 1951, ASA established the Standards Medal. This will be awarded each year to an individual who has shown leadership in the development and application of voluntary standards. The first presentation was made to Dr. P. G. Agnew on October 24, 1951, during the National Standardization Conference which ASA arranges annually.

At the same conference, The Honorable Herbert Hoover received the Howard Coonley Medal, which is awarded yearly by ASA to an executive who by his practice and preachments has furthered the national economy through voluntary standardization.

Work With Other Organizations. During the year, a revision of Standard Basic Impulse Insulation Levels 450 Kv to 1,050 Kv Inclusive was completed jointly by AIEE, Edison Electric Institute, and the National Electrical Manufacturers Association.

A joint AIEE-NEMA Committee on Textile Mill Control Enclosures has been formed, and considerable progress has been made toward obtaining a standard applicable to the conditions peculiar to textile mills.

UNITED STATES NATIONAL COMMITTEE OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

At the invitation of the Portuguese National Committee of the International Electrotechnical Commision (IEC), the annual IEC meeting was held in Estoril, Portugal, July 4–12, 1951. Meetings of eight technical committees and the Committee of Action were held. Fourteen countries were represented by 153 delegates. The United States National Committee (USNC) delegation to these meetings, headed by H. S. Osborne, President, and R. C. Sogge, Vice-President, consisted of 12 technical experts.

As a result of these meetings, two new technical committees have been organized; one on instrument transformers and the other on lightning arresters. The USNC has accepted the secretariat for the Lightning Arrester Committee and the British National Committee will act as the secretariat for the Committee on Instrument Transformers.

The Committee of Action, at its meeting on July 10, 1951, voted for the resumption of work on measuring instruments. The Hungarian National Committee, which holds the secretariat for this work, has been inactive for some time but has now agreed to go ahead with the work.

During the past year, Spain was readmitted to membership in the IEC. Voting is now under way for the readmission of Germany, and an application from Brazil for membership is also being voted on at the present time.

Two new international specifications in the field of electric lamps recently have been approved. They are

International Recommendations Regarding Lamp Caps and Holders Together With Gauges for the Control of Interchangeability (IEC Publication *61*).

International Specification for Tungsten Filament Lamps for General Service (IEC Publication *64*).

Work is going forward rapidly on the revision of the International Electrotechnical Vocabulary, and it is hoped that this project will be completed by 1954. Progress is also being made in the fields of turbine-type generators and rotating electric machinery; work is continuing on motor frame dimensions, standard voltages, radio communication; agreement on a draft standard for power and distribution transformers has been reached, and an Editing Committee will put this draft into final form for approval by the national committees. Work has been started on the classification of electrical insulating materials and the formulation of rules for high-voltage tests to be applied to transformers and switchgear.

Specific technical work completed for final letter ballot of the member-countries of the IEC under the so-called "Six Months' Rule" comprises the following documents:

Fuses for Voltages Not Exceeding 1,000 Volts for Alternating and Direct Current.

Standard Sheets for Caps and Holders for Electric Lamps.

Standardization of Rated Currents of Fuse-Links of Low-Voltage Fuses.

Basic Climatic and Mechanical Robustness Testing Procedure for Components.

Standards for Plugs and Socket Outlets for Domestic and Similar General Use.

Shunt Capacitors for Power Systems.

Code on Electric Installations on Ships.

Standardization of Measurements of Receivers for Amplitude-Modulation Broadcast Transmission.

The following were re-elected as officers of the USNC for the calendar year 1952:

H. S. Osborne, President; Chief Engineer, American Telephone and Telegraph Company.

P. H. Chase, Vice-President; Chief Engineer, Philadelphia Electric Company.

R. C. Sogge, Vice-President; Manager, Standards Division, General Electric Company.

The 1952 meetings of the IEC will be held in Scheveningen, Holland, September 3 to 13. At this time, the following technical committees will meet:

Technical Committee 2—Rotating Machinery
  Subcommittee 2B—Dimensions of Motors
  Subcommittee 2C—Classification of Insulating Materials
  Subcommittee 2D—Losses and Methods of Declaring Efficiency
Technical Committee 3—Graphical Symbols
Technical Committee 8—Standard Voltages, Current Ratings, and Frequencies
Technical Committee 12—Radio Communications
  Subcommittee 12-1: Measurements
  Subcommittee 12-2: Safety
  Subcommittee 12-3: Components
  Subcommittee 12-4: Electron Tubes
Technical Committee 15—Insulating Materials
Technical Committee 17—Switchgear
Technical Committee 22—Mercury-Arc Rectifiers
Technical Committee 31—Flameproof Enclosures
Technical Committee 33—Power Capacitors
Technical Committee 35—Dry Cells and Batteries
Technical Committee 36—Insulators
Committee of Action
Council

The United States National Committee will be well represented at the 1952 session.

As required by the Statutes of the IEC, nominations for president were solicited early in 1952. Dr. H. S. Osborne, President of the United States National Committee, was nominated by five countries, and was the only candidate nominated. It is therefore expected that he will be elected the next president of the IEC at the meeting of the Council to be held in Scheveningen, Holland, on September 10, 1952.

COMMITTEE ON STUDENT BRANCHES

When the Bylaws were amended to increase the dues for Student members from $3 to $5 per year, the Board of Directors requested the Committee on Student Branches to investigate and report on ways and means by which the Institute could better serve the student program. The main activity of this committee has been the investigation of the numerous suggestions received in this connection.

The Board of Directors approved the recommendation of the Committee on Student Branches that the Institute supplement, if necessary, the Members-for-Life Fund to provide travel allowances for all Districts to send the winners of the District Branch Paper Competitions to the Summer General Meeting. Previously, the travel allowances were provided in even years for the winners from even-numbered Districts, and in odd years for the winners from odd-numbered Districts. The Committee on Members-for-Life Fund found it possible to provide allowances for all Districts, and this plan will be in effect for the first time at the Minneapolis meeting.

Another recommendation approved by the Board of Directors was that of having the Institute provide lapel pins for incoming Student members.

A subject still under investigation is that of increasing the allotment made for the operation of Student Branches. At present each Branch may receive up to $25 per year. Many suggestions on the subject have been received, and the committee is attempting to arrive at a workable scheme that will fairly serve the needs of the Branches.

Upon the recommendation of the Committee on Student Branches, the Board of Directors approved the withdrawal of the Harvard University Student Branch from the Institute.

The Institute has long recognized that one of the best sources of members is the group of Student members who are elected to Associate Member grade each year. The Committee on Student Branches and the Branch Counselors are co-operating with the Sections and membership committees in a new plan of maintaining contact with Student members after graduation. Under this plan, Branch Counselors are furnished cards on which is requested the name and address of the company who has employed the Student. These cards are to be filled out just before graduation and returned to headquarters. Headquarters in turn will forward the cards to the Sections in which the Students will be located. The local Section will then invite all new Student members who move into the area to attend Section meetings and to participate in the activities of the Section.

The committee held two meetings, one in Toronto, Ontario, Canada, June 26, 1951, and the other in New York, N. Y., January 21, 1952.

TECHNICAL ADVISORY COMMITTEE

Technical Committee Organization and Scopes. An apparent conflict in scope between the Committees on Instruments and Measurements (Science and Electronics Division) and Carrier Current (Power Division) focused attention on the need to determine the most desirable sphere of activity for the former committee. This was resolved by establishing the general principle that the Committee on Instruments and Measurements will be concerned with fundamentals, and other committees with specific applications.

The subject of bus design was deleted from the scope of the Committee on Power Generation, open-type bus design was assigned to the Committee on Substations, and metal-enclosed busses and other busses included in switchgear assemblies were assigned to the Committee on Switchgear.

The subject of electric couplings was added to the scope of the Committee on Rotating Machinery.

The Subcommittee on Electrical Properties for Solids and Liquids was replaced by two subcommittees: Subcommittee on Semiconductors and Subcommittee on Dielectrics.

In collaboration with the Committee on Instruments and Measurements, a new scope was prepared for the Subcommittee on Instrumentation for Resistance Welding, which required a slight modification of the scope for the Committee on Welding (Industry Division).

Special Technical Conferences. These conferences have become a permanent Institute technical activity, and have been operated on a financially self-sustaining basis.

It was recommended to the Board of Directors, which approved, that the 80 per cent requirement for advance subscription of reports be removed.

After three annual conferences on Electronic Instrumentation and Nucleonics in Medicine had been conducted jointly by AIEE and Institute of Radio Engineers (IRE), the latter withdrew its sponsorship from the fourth annual conference, which was held January 7–8, 1952. An effort will be made to induce the IRE to participate in future conferences.

Other special technical conferences held during the year are covered in another section of the Board of Directors' Report.

AIEE Participation in Centennial of Engineering. Each division appointed a Chicago member to represent it on the local committee in charge of arrangements for this special meeting. Final programs have been arranged for the 3 days of AIEE-sponsored sessions in Chicago, Ill., September 10–12, 1952.

Member Classification. As mentioned in last year's report, "the lack of a classification of Institute membership according to interest has been a drawback in the preparation of mailing lists to publicize special technical conferences and other activities." In the interests of economy and expediency, it was decided to use the classification obtained by the Publication Committee for the new divisional proceedings: 1. Power; 2. Communication, and Science and Electronics; and 3. Industry and General Applications.

Classification of Papers. Considerable dissatisfaction has been expressed over the present classification of papers; namely, "*Transactions*," "Advance Copy Only," and "Conference (or District) Papers." No solution has been found, and the matter continues under discussion with the Technical Program and Publication Committees, and at forums.

Safety Committee Liaison. At the request of the Committee on Safety, each

division committee appointed a liaison member to represent it on that committee. It will be the duty of this representative to encourage the several technical committees to give additional attention to safety matters in their respective fields.

Forecast of Programs for Meetings. During September, a forecast was made by each division of the numbers of sessions and papers by classifications it planned to present during the budget year. Based on this forecast, the Technical Program Committee made its annual budget request.

Forums of Technical Committee Chairmen. Forums, instituted last year, were continued at the Toronto, Canada; Cleveland, Ohio; and New York, N. Y., meetings. The major subjects discussed were

1. Conference papers.
2. Divisional operation of technical activities.
3. Procedure for balloting on Standards.
4. Technical committee representation on Board of Directors.
5. Changes in procedure of awarding Institute prizes.
6. Publication of *Proceedings* on a divisional basis.
7. Changes in classification of technical papers.

Committee on Technical Operations. As a result of intensive study, assisted by discussion at forums, the Committee on Planning and Co-ordination recommended to the Board of Directors, which approved, that the Technical Advisory and Technical Program Committees be merged into a new Committee on Technical Operations. The membership of the new committee, in addition to the chairmen of the division committees, will include the chairmen of the Committees on Standards, Publications, Education, Management, Research, Safety, and Award of Institute Prizes.

The general scope of this new committee is to supervise the technical affairs of the Institute. The new committee will be instituted in the administrative year 1952–53.

TECHNICAL PROGRAM COMMITTEE

Two meetings of the Technical Program Committee were held during 1951–52. These were well-attended, so that the members of the committee had an opportunity to contribute their thoughts to the problems of the smooth functioning of the committee in carrying out the directives of the Board of Directors with respect to technical paper presentation. This guidance was of great assistance to the chairman and the secretary in handling the large number of day-to-day items that constitute the bulk of the work of arrangement and scheduling of technical papers.

The volume of technical papers is now so great that, even with the increased number of District and general meetings and technical conferences, it is difficult to obtain sufficient space for the large number of technical sessions necessary at the general meetings. In view of the steady increase in Institute membership, this problem of space is likely to become more, rather than less, acute, and only by the hard work and skillful planning by the regular staff of the Institute have the large number of papers been handled with what is hoped is reasonable satisfaction, both to the authors and the general membership.

The combination of the Technical Program Committee and the Technical Advisory Committee into a single committee for the coming year may result in smoother operation of the whole technical program and help to streamline operations in connection with the steadily increasing number of technical papers.

COMMITTEE ON TRANSFERS

The Committee on Transfers issued a general letter to the Section chairmen calling attention to the effects on transfers work of recent changes in the Constitution, and emphasizing several important points in connection with the work. A meeting was held in New York, in January, which resulted in recommendations for changes in the Bylaws to change materially the organization of the committee. Work on the Operations Guide for Section Transfers Committee is in progress, but not completed.

TECHNICAL DIVISIONS AND COMMITTEES

Communication Division

COMMUNICATION DIVISION COMMITTEE

Of considerable assistance in co-ordinating the activities of the division were two well-attended committee meetings, one at the Fall General Meeting, and one at the Winter General Meeting. This committee has been keenly conscious of its responsibility to the communication-interested segment of Institute membership as indicated by the fields-of-interest survey. It has striven to maintain its activities and technical paper production proportional to the interest indicated by that census. Technical committees under the division have been urged to sponsor material for *Electrical Engineering* publication at least sufficient to permit the publication of 14 per cent specialized communication material. The 3-part publication plan is favored as having great possibility of winning and holding the communication engineers' interest in the Institute. A secondary responsibility of the committee has been such guidance as necessary to prevent disporportionate emphasis on any one branch of the communication field.

The year has been particularly fruitful in its announcement of notable communication achievements. Among these may be mentioned the development of junction-type transistors, the popularization of television, the nation-wide television program network, toll-line dialing, and a new subscribers' telephone set, in telephony; machine switching in telegraphy; multiplexing in radio telegraphy; and submarine repeaters in both telephony and telegraphy. All these advances have been the subjects of technical sessions and conferences mutually helpful to workers in the field, and have been well-recorded in the permanent communication literature.

COMMITTEE ON COMMUNICATION SWITCHING SYSTEMS

Two committee meetings were held, and two technical sessions were sponsored. The session held at the Fall General Meeting covered a Swedish crossbar switching system, counting and register circuits, contact protection, and the theory of holding time measurements. The session was well-attended, and each paper was followed by an interesting discussion. The session at the Winter General Meeting covered foreign switching systems and apparatus, a survey of telephone switching in Alaska, and the development of Rural Electrification Administration requirements for switching equipment in the United States. The papers were received with considerable interest.

The committee has made plans to sponsor a symposium on nation-wide toll dialing at the Summer General Meeting. This is a subject of great interest and importance in telephone switching. The committee is also planning technical sessions for the Fall General Meeting and for the 1953 Winter General Meeting.

COMMITTEE ON RADIO COMMUNICATIONS SYSTEMS

Two meetings of the committee were held during the year. A report entitled "Lightning Protection of Base Stations in the Mobile Radio Service" was published in *Electrical Engineering* (*EE, Jan '52, pp 73–5*) and presented at a technical session during the Winter General Meeting. This has been submitted to the Standards Committee as a recommended practice.

One session each was sponsored at the Summer, Fall, and Winter General Meetings, and one jointly sponsored with the Committee on Telegraph Systems on "Wire and Radio Telegraph Systems" was held during the Winter General Meeting. The committee also assisted in planning a session on radio communications at the Pacific General Meeting.

COMMITTEE ON SPECIAL COMMUNICATIONS APPLICATIONS

This committee has served to handle subjects that do not logically fall within the scope of other committees in the Communication Division. Activities concerned with audio-frequency filters, frequency stabilization, radio dispatching system, and narrow-band speech spectrums have been handled during the past year. The committee has processed several papers covering these topics, which cover a wide range of interest.

COMMITTEE ON TELEVISION AND AURAL BROADCASTING SYSTEMS

During the year, the committee work continued to emphasize the arranging for technical sessions and papers. In this direction, an interesting and well-attended session on color television was sponsored at the Fall General Meeting. One meeting of the committee was held during the Winter General Meeting, at which activities were reviewed. A report was prepared, reviewing the outstanding developments during 1951 in the field of broadcasting, and arrangements were made for a paper on broadcasting to be presented at the Centennial of Engineering session on communications. No new work on standardization was undertaken.

COMMITTEE ON WIRE COMMUNICATIONS SYSTEMS

This committee held meetings, and sponsored technical sessions at the Summer, Pacific, Fall, and Winter General Meetings, and has made plans for future meetings.

The Winter General Meeting session was an experiment in combining talks by experts in the mechanism of communication from the speaking, writing, and electrical design fields. This meeting was unusually well-attended, and there are plans to repeat such a departure from the usual technical paper

sessions at some future general meeting.

The matter of establishing standards of various types was carried forward slowly because of the pressure of defense work in certain areas. It is still not clear that these needed standards can be prepared in the present state of the art.

General Applications Division

GENERAL APPLICATIONS DIVISION COMMITTEE

The General Applications Division Committee serves under the present AIEE organization as the co-ordinator for five technical committees. This committee has encouraged the chairmen of these five technical committees which it represents to deal directly with headquarters and with the Technical Advisory and Technical Program Committees, as far as possible, both to save time and to give a sense of closer contact with Institute affairs.

In connection with the Centennial of Engineering, in Chicago, Ill., September 1952, the General Applications Division Committee has undertaken to sponsor a half-day session, and arrangements have been made for the five constituent committees of this division to prepare authoritative compilations of the historical development of electrical engineering, in these five respective fields, during the past century. These fields are: Production and Application of Light; Land Transportation; Marine Transportation; Air Transportation; and Domestic Appliances. Work on these five papers is under way, and the program recommended by the committee has been tentatively accepted.

COMMITTEE ON AIR TRANSPORTATION

The Committee on Air Transportation sponsored a technical conference on aircraft electrical applications, in Los Angeles, Calif., October 8–10, 1951. Twenty-six papers were presented at this conference. The attendance at the meeting exceeded the expectations of the committee, and the meeting rooms were filled to capacity at every session. The committee held its annual meeting on October 11, and decided that air transportation sessions would be scheduled at the South West District Meeting in April 1952, to present several papers which had previously been approved, but not formally presented. Plans also were made to have the main annual air transportation session for 1952 held in conjunction with the Middle Eastern District Meeting, in October 1952.

Aircraft Electric Rotating Machinery Subcommittee. The subcommittee is presently co-operating with the Systems Subcommittee in the review of the "Aircraft Electric System Guide Report." It is expected that revised drafts of obsolete sections of this report will be prepared by this subcommittee during 1952. The proposed test code for d-c machines has been approved by the Committee on Air Transportation for submission to the Standards Committee.

This subcommittee also has been charged with the responsibility of determining the type of curves and data on rotating machines that are needed to apply these machines by aircraft manufacturers. The committee will determine what data are desired on d-c machines, and the feasibility of standardizing on the manner of presenting the data.

Principles of Altitude Rating of Electric Apparatus Subcommittee. When this subcommittee was originally established, it was believed that it would be a relatively simple task to establish altitude derating charts for rotating apparatus. It has since been learned that the problem is much more complex, and it is not anticipated that a single altitude derating chart will be possible. The assignment of the subcommittee is being reviewed, with the idea of redefining it to enable the subcommittee to work more effectively.

Aircraft Electric Systems Subcommittee. A program of reviewing and revising the "Report on Aircraft Electric System Guide" was undertaken in 1951. It is expected that this work will continue through 1952, and the result will be an expanded and up-to-date systems guide. The committee is also conducting a program on systems stability, in order to allow the computation of system transient-voltage recovery and maximum short-circuit currents on aircraft electric systems.

Aircraft Electric Control, Protective Devices, and Cable Subcommittee. This subcommittee is completing its review of the proposed standard, AIEE *20A*, for low-voltage air circuit breakers for use on aircraft. A test code for carbon-pile voltage regulators for aircraft has been prepared in preliminary form, and has been circulated to the members of the Committee on Air Transportation for comments and review. This subcommittee also is co-operating with the Systems Subcommittee in reviewing the Systems Guide.

COMMITTEE ON DOMESTIC AND COMMERCIAL APPLICATIONS

The activities of the committee have been carried on during the past year through the medium of four subcommittees.

The Subcommittee on Electric Space Heating and Heat Pumps for the East Coast sponsored a very successful session at the Winter General Meeting. This meeting was unusually well-attended, and a tremendous interest has built up in this possible method of domestic and commercial space heating, as well as other applications of the heat pump for heating water and the dehumidification of moist areas in the home.

The Subcommittee on Electric Space Heating and Heat Pumps for the Pacific Coast sponsored a very successful session at the Pacific General Meeting. This session was particularly interesting to the group, because in this territory is probably the most fruitful field for electric space heating due to the availability of electric power.

The Subcommittee on Domestic Appliances held two technical conferences on domestic appliances during the past two years, one in Cleveland, Ohio, and one at Battelle Memorial Institute, in Columbus. Because of the interest built up in this subject, another technical conference is being planned in co-operation with the Cincinnati Section, to be held at the Engineering Society's building in Cincinnati, May 16–17. The general theme of this meeting is "Appliance Controls."

The Subcommittee on Farm Electrification participated in the 1951 National Farm Electrification Conference held in Cincinnati. This subcommittee is again working with the steering committee for the National Farm Electrification Conference to be held in the fall of 1952. The National Farm Electrification Conference is sponsored by interested technical and professional groups, as well as the interested governmental agencies, and the subcommittee is arranging for our contribution to this program.

In the past, there have been limited opportunities and activities for the engineers in the appliance industry in the AIEE program. This has resulted in a very low percentage of appliance engineers having membership in AIEE. The committee has made considerable progress in compiling a roster of all manufacturing companies and their engineering personnel in the appliance and related companies, with a view of soliciting their actual support for its program and eventual Institute membership.

COMMITTEE ON LAND TRANSPORTATION

If attendance is the measure of interest and discussion of papers is the measure of enthusiasm, the Committee on Land Transportation has shown definite indications of increasing activity and progress. A total of 150 attended the two Toronto sessions; a total of 235 attended the two New York sessions. Time allotted to discussion proved to be inadequate at both general meetings.

The committee thinks that this increasing interest in land transportation subjects reflects its activities, particularly its ability to plan and present acceptable papers. The committee's assignment and scope cover a large field of rail transportation: railroad, transit, mining, and industrial. To cope with these diversified transportation operations, committee members have been selected from all classifications, both operating and manufacturing. At present, the members of the committee are divided into the following groups: industry, railroads, transit, power, consulting, colleges, mines, and publications, with geographical representation from the western United States, central United States, eastern United States, and Canada.

During the past year, one new subcommittee was added, one subcommittee was disbanded, one subcommittee was reactivated, and three subcommittees were retained. The latter three include: Heavy Traction Papers and Plans, Light Traction Papers and Plans, and Revision of AIEE Standard Number *16* (Electric Railway Control Apparatus) ASA *C48*. The new subcommittee was selected to supervise the preparation of an historic paper to be presented at the Centennial of Engineering. The co-operation of the American Transit Association has been assured for light traction coverage. The author of the paper was selected by the subcommittee. The work of compiling data and submitting a report has been completed by the Heavy Traction Electrification Data Subcommittee. This report includes information on catenary overhead, third rail, substations, and power supply, covering domestic steamroad electrifications. The subcommittee's report has been accepted and the subcommittee disbanded.

A representative of the Committee on Land Transportation attended the London, England, meeting of the International Electrotechnical Commission, last August. At

the January meeting of the committee, the representative stated that the British were especially anxious for our group to take part in this activity. There is an advantage in having the various standards on a common basis. The American Standards need revision in any event. At the January meeting of the committee, it was decided that AIEE Committee Number *11* should be re-established. A subcommittee was appointed and the suggestion offered that these men should be included on the ASA Committee *C-35*.

The Committee on Land Transportation was very fortunate in having two representatives at the Annecy Conference of the French National Railways, last October. Electrification of railroads is of major importance to European operators as evidenced by the presentation of many papers (three days), and the attendance of 300 engineers. Both representatives of this committee presented papers on the Annecy Conference at the 1952 Winter General Meeting.

During the past year, this committee sponsored a total of 19 AIEE papers; 8 at the Summer General Meeting, 10 at the Winter General Meeting, and one at the South West District Meeting. The subjects covered were both heavy traction and light traction. Railroads, transit, and rapid transit were included. The Diesel locomotive, the electric locomotive, the trolley coach, and the rapid transit car were subjects of papers. Power contracts, fuel, regeneration, wheel slip, traction motors and control, economic study of power supply, and co-ordination of city transit received more explicit technical discussion. Unusual interest was evident during the presentation of two excellent papers on the two new types of locomotives for the Pennsylvania Railroad at the Winter General Meeting. One locomotive paper covered an improved single-phase type, and the other paper covered the rectifier type. The committee believes the 19 papers covered its field of endeavor well, and in addition to these papers an effort is being made to secure papers, not of a general type, on recent mining and industrial haulage developments.

Future plans for the selection of papers for coming general meetings include especially planned sessions for the Winter General Meeting. One session will be devoted to a symposium on rapid transit and subway development, and another session will be a symposium on Dieselization, preceded by an appropriate introduction by the electrical engineer of one of the leading railroads.

COMMITTEE ON PRODUCTION AND APPLICATION OF LIGHT

A valuable conference session under the auspices of the committee was held at the Fall General Meeting, concerning the selection of circuit and lamp designs to conserve critical materials. The discussion involved the consideration of lamps and auxiliaries, electric distribution and control, and industrial experience with some of the systems described.

At the annual committee meeting, held during the Winter General Meeting, plans were made for the committee participation in the Centennial of Engineering, and for sessions at the Winter General Meeting.

A subcommittee was appointed to handle the participation in the Centennial of Engineering, which is to consist of the preparation of an historical paper, "Electric Lighting in the First Century of Engineering"; a presentation of a condensed version of the paper in Chicago, Ill., in September; and the supervision of semipermanent exhibits concerning the production and application of light at the Museum of Science and Industry in Chicago.

The committee is planning a full day's session at the next Winter General Meeting. The morning session will be devoted to a comprehensive review of ultraviolet and infrared sources and applications. The afternoon session will be a report of progress in the production and application of light, the presentation to cover the developments in the years since such a progress report was last made.

COMMITTEE ON MARINE TRANSPORTATION

The last meeting of the committee during the year was held on May 11, 1951. At this meeting, it was decided that the extensive additions, clarifications, and revisions agreed upon during the several meetings since the 1948 edition of Standard *45*, "Recommended Practice for Electric Installations on Shipboard," should be compiled and submitted to the Standards Committee of the Institute for approval. The decision was made at this time, as it was believed desirable to issue a revised edition complete in itself, rather than issue a long addendum requiring extensive correlation with the 1948 edition. The revision was approved by the Standards Committee, and issued in December 1951.

The principal changes in the new edition cover: safety provisions for motor-generator sets; simplified and standardized recommendations covering storage batteries; clarified recommendations for generator switchboard equipment; rationalized recommendations for distribution circuit overcurrent protection; greater safety in and simpler installations of motor controllers; improved lighting installations; clarified recommendations for fire alarm systems; recommendations covering marine-type transformers; cable installations in line with presently accepted practice; clarified electric propulsion equipment recommendations; rationalized cable current-carrying capacities; and corrected cable dimensions and weights.

The committee has compiled data on subjects of interest to those concerned in marine electrical fields, which are inherently not suitable for inclusion in an Institute standard, such as the latest known requirements of the Suez Canal authorities for special lights. Information on such subjects will be supplied on request when available.

Liaison with the Committees on Rotating Machinery and Instruments and Measurements was provided to insure co-ordinated action in the marine field with the general policies of the Institute.

Industry Division

COMMITTEE ON CHEMICAL, ELECTROCHEMICAL, AND ELECTROTHERMAL APPLICATIONS

A meeting was held at the Winter General Meeting, which was attended by the chairmen of all the divisions. Changing of the name of the committee was discussed, and detailed plans were made for activities for the coming year. Two sessions were planned for Minneapolis, Minn., one for Phoenix, Ariz., two for New Orleans, La., and three for New York, N. Y.

During the past year, a session was held in Toronto, on "The Petroleum Industry in Canada," a session in Portland, Oreg., on "The Aluminum Industry" and "Cathodic Protection," a session in Cleveland, Ohio, on "Cathodic Protection," and two sessions in New York, on "Electrical Applications in Pipe-Line Transportation."

Cathodic Protection Subcommittee. Meetings were held in Cleveland and New York, and one is scheduled for New Orleans. This committee is continuing its work on the 5-year program, and is preparing a series of articles for *Electrical Engineering* on "Fundamentals and Applications." Activities include co-ordination with other groups, standardization, railway signal systems, grounding practices, research and short courses in universities, instrumentation, rectifiers, cable sheaths, nonferrous metals, and the preparation of a manual.

Full sessions are planned for New Orleans and New York, with some papers for presentation at other meetings.

Chemical Industry Subcommittee is planning for a session in Phoenix; on "The Chemical Industry in the West," and one in New Orleans, on "The Chemical Industry in the South," and is completing a summary of the data contained in its numerous papers on "Cable Insulation for Chemical Plants."

Electrochemical Processes Subcommittee is preparing data for sessions on history and development of major processes for aluminum, magnesium, chlorine, and caustic soda.

Electrothermal Processes Subcommittee is preparing a session on "Modern Practices for Electric Furnaces" for presentation in Minneapolis.

Petroleum Industry Subcommittee held a meeting in New York, and has a meeting scheduled for New Orleans. A session on "The Petroleum Industry in the South," which will continue the work in New York on "Electrical Applications in Pipe-Line Transportation," will be presented in New Orleans.

Storage Batteries Subcommittee is continuing its studies on standardization, and will sponsor a session on "Storage Batteries" in Minneapolis.

COMMITTEE ON ELECTRIC HEATING

Interest in electric heating has noticeably increased during the past year, with the result that activities of the Committee on Electric Heating have been well-supported, and greater incentive is now in evidence toward the furthering of its objectives. Two sessions on electric heating were sponsored at the Winter General Meeting. Fifteen papers on induction and dielectric heating were sponsored at a technical conference in Cleveland, February 19–20. The Subcommittee on Technical Data, Radiation Heating, Induction and Dielectric Heating has been active, with several committee meetings, trips, and technical contributions in evidence.

During the past year, AIEE Standards on radiation measurements above 30 megacycles were adopted as a result of joint efforts with the Federal Communications Commission and the Institute of Radio Engineers. Standards on induction and dielectric heating equipment have been adopted by the committee, and favorable

action by the AIEE Standards Committee is anticipated. The committee is continuing to co-operate with the Ovens and Furnaces Committee of the National Fire Protection Association on equipment standards for electric ovens and furnaces.

Plans are under way for West Coast and Midwest special technical conferences on various phases of electric heating during the coming year.

COMMITTEE ON ELECTRIC WELDING

A Conference on Electric Welding was held in the Rackham Memorial Building, Detroit, Mich., April 16–18, 1952, sponsored by this committee, in co-operation with the AIEE Michigan Section, the American Welding Society, and the Industrial Electrical Engineers' Society of Detroit, which is covered in the report on technical conferences.

Subcommittee on Instrumentation for Resistance Welding was organized to deal primarily with the application of various instruments to electric welding. The membership was drawn from the Committee on Electric Welding, outside industry, and representatives of other interested groups, including American Welding Society, National Electrical Manufacturers Association, and the AIEE Committee on Instruments and Measurements. A new scope has been authorized for this subcommittee, which will appear with other committee and subcommittee scopes in the 1952 Year Book.

Subcommittee on Fundamental Electric Arc Research reported the completion of the first step in the preparation of the "Bibliography on Electric Arcs." This bibliography now contains about 1,200 entries, arranged in alphabetical order by author. Because of time limitations, many items submitted by members and other contributors have not yet been included. The work of checking and introducing the additional entries is proceeding as rapidly as possible with the volunteer services available.

Only a limited number of copies of the bibliography have been distributed. The next big undertaking will be to introduce a code so that the entries may be listed by subject matter rather than by author. This will require some study as to a suitable breakdown of the subject and an adequate code.

Subcommittee on Power Supply for Resistance Welding Machines has completed and published a new report entitled "Power Supply for Resistance Welding Machines." This report supersedes a similar AIEE report published in 1940 and 1941, and fills an industry need for the latest available information on resistance welding equipment and methods of providing an adequate power supply.

The new report covers the interests of the manufacturers of resistance welding machines, the utilities which supply the energy for welding, and the industrial user of the welding process, stressing their interdependence.

The Manufacturer's Section contains in detail the design and characteristics of the many types of welding machines, both new and old, and discussions of the various elements of control used. The Utilities' Section, written by utility operating engineers, covers the problems involved in serving instantaneous low-power-factor loads, simple methods of calculating expected voltage drop, allowable light flicker, and solutions of the power supply problem, as well as the economics involved.

The User's Section details the characteristics of transformers and plant feeders, the procedure required in plant distribution design to meet the problems of voltage drop, thermal demands, and interference between welders, which will cause spoilage of work. It also covers the subject of capacitor application, protective equipment, use of bus duct, and guides for economic distribution design.

The Typical Installations Section presents selected data on actual industrial welding installations in service, both large and small, which may serve as a further guide to design. The completed report, similar in size and form to the AIEE "Red Book" on Electric Power Distribution for Industrial Plants, was made ready for publication coincident with the third Conference on Electric Welding, in April 1952.

In order to carry on the foregoing work, it was necessary to hold four meetings of the Committee on Electric Welding and four meetings of the Power Supply Subcommittee. The work of the Arc Research Subcommittee was done without any meetings, co-ordinating the activities by correspondence.

COMMITTEE ON FEEDBACK CONTROL SYSTEMS

The committee met at the Summer and Winter General Meetings, and technical sessions were sponsored at the Summer, Fall, and Winter General Meetings. In addition, technical papers recommended by the committee were presented at the Pacific General Meeting, the South West District Meeting, and the North Eastern District Meeting. The committee was represented at the South West Conference on Feedback Control Systems, which was held March 10–11, 1952, in Dallas, Tex.

Both prize-winning papers in the Industry Division were sponsored by the Committee on Feedback Control Systems. First prize went to the paper, "Transient Response of Small 2-Phase Induction Motors," by A. M. Hopkin, and second prize went to the paper, "Servomechanism Transient Performance From Decibel–Log Frequency Plots," by H. Harris, M. J. Kirby, and E. F. von Arx.

Terminology and Nomenclature Subcommittee. During the year, five meetings of this subcommittee were held, with representation from The American Society of Mechanical Engineers, and in co-operation with the American Standards Association.

In order to disseminate more widely the work of the subcommittee, a report entitled "Proposed Symbols and Terms for Feedback Control Systems" was published in the October 1951 issue of *Electrical Engineering* (*pages 905–09*). That the report achieved its purpose is indicated by the large volume of correspondence, both critical and commendatory, that was received. The subcommittee has taken note of the suggestions, and is continuing in its efforts to compile standard terminology and nomenclature. A report on this work is intended for June 1952.

Bibliography Subcommittee. In co-operation with a similar subcommittee under the Committee on Industrial Control, this subcommittee is engaged in compiling a bibliography on feedback control systems.

Feedback Control Systems Conference. In response to considerable demand, the subcommittee sponsored a Feedback Control Systems Conference, which was held December 6–7, 1951, in Atlantic City, N. J. Further details are given elsewhere in this report.

COMMITTEE ON GENERAL INDUSTRY APPLICATIONS

Since this committee is essentially a combination of several subcommittees, the greatest part of its activity lies in the work done by the subcommittees. The needs of industry are believed to be better served by special technical conferences strategically located than by technical sessions at general meetings. The special conference is centered around a particular industry, and its location can be selected so that geographically it is centrally located.

Machine Tool Subcommittee staged its annual conference on machine tools in Rockford, Ill., November 14–16, 1951, including several inspection trips to representative industries in Rockford. A similar conference is planned for Schenectady, N. Y., in the fall of 1952. The Machine Tool Subcommittee has developed a very successful system of rotating its chairman each year, depending on the location of the meeting that year.

Materials Handling Subcommittee provided a very interesting day of technical papers for the Fall General Meeting.

Pulp and Paper Subcommittee is struggling to reorganize and plan some activity. The pulp and paper industry's need of outlets for technical discussion is provided by other technical organizations, and it is questionable whether an AIEE Pulp and Paper Subcommittee is necessary.

Rubber and Plastics Subcommittee is reviving its annual conference in Akron, Ohio, this year, after missing one year. The date was April 28, and papers on the program were prepared by users as well as manufacturers of electric equipment.

Textile Subcommittee is one of the most active of the subcommittees, having embarked on a program of standardization of "lint atmosphere control enclosures," in addition to staging several special technical conferences each year. The work of drafting a functional specification applying to design of textile mill lint atmosphere control enclosure began in 1950. Results of this work were included in an article printed widely in textile industry trade magazines, and comments of industry people brought about some modifications. The subject was then referred to the National Electrical Manufacturers Association (NEMA), and a meeting was held in New York concurrently with the Winter General Meeting, in order to review details with NEMA representatives. Further activity is expected this year after both groups have reviewed the discussion in the New York meeting. Technical conferences this year follow the usual pattern of one in the North and one in the South. The northern conference was held in Philadelphia, Pa., April 24, and the southern conference in Atlanta, Ga., May 1 and 2.

West Coast Subcommittee sponsored a

technical program at the Pacific General Meeting on subjects connected with the lumber industry. The meeting was well-attended.

General. A session on "Electronics in Industry" was contributed to jointly by all subcommittees for the Winter General Meeting. A program of subjects which is of mutual interest to all industries is difficult to plan, and it is probable that programs of this type will be infrequent and arranged only as the need arises. A business meeting of the main committee at the Winter General Meeting this year was very well-attended.

COMMITTEE ON INDUSTRIAL CONTROL

The committee held two meetings during the past year, one during the Fall General Meeting, and the other during the Winter General Meeting. The committee sponsored two technical sessions at the Fall General Meeting, and one technical session at the Winter General Meeting. Plans are under way at the present time for two technical sessions to be sponsored at the Winter General Meeting of 1953. It is planned to sponsor more technical sessions to be held jointly with other committees and subcommittees of the Industry Division, since it is the concensus of the Committee on Industrial Control that this committee can be of greater service in joint sponsorship of technical sessions than by holding its own sessions. Such joint sponsorship, it is believed, will stimulate many papers on the application of industrial control in different industries.

Standards Subcommittee has been studying for some time the possible extension of symbols to be used in conjunction with connection and wiring diagrams, and has developed proposed symbols to show the functions and uses of various industrial control devices. Representative diagrams using these symbols are being prepared for presentation to the main committee for consideration, before submission to the American Standards Association for inclusion in an American Standard.

Test Codes Subcommittee has been studying proposed test codes and test procedures for industrial control, and is ready to submit a draft of procedures for conduction temperature rise tests on a-c and d-c magnetic controllers. This will be submitted to the general committee for consideration and modification at its next meeting.

Electronic Control Subcommittee has established "task forces" for specific jobs of preparing standards on electronic motor control, photoelectric webb control, and photoelectric relays. The "task force" chairmen have organized their groups, and a basic outline of their work has been agreed upon.

Regulators and Feedback Systems Subcommittee is a liaison committee and listening post for other committees concerned with feedback control systems, and will co-ordinate the work of other committees with needs of the industrial control industry on standards to be established, nomenclature, and products used in such systems.

COMMITTEE ON MINING AND METAL INDUSTRY

The Committee on Mining and Metal Industry has three subcommittees. The Metal Industries Subcommittee covers activities in the field of metals. The Eastern Mining Subcommittee, the members of which are located generally in the eastern part of the country, covers activities with relation to coal mining. The Western Mining Subcommittee consists of members in the western part of the country engaged in mining copper, potash, lead, silver, gold, and other ores.

The Western Mining Subcommittee has held separate committee meetings. Full committee meetings for the three subcommittees were held at the Fall General Meeting, and at the Winter General Meeting.

The committee sponsored two sessions, one on metals, and one on mining, at the Summer General Meeting, and also sponsored two sessions, one on mining, and one on metals, at the Fall General Meeting. Plans are now being completed for sessions at the Summer General Meeting, and at the Pacific General Meeting. The sessions in Minneapolis will be on the subject of ore beneficiation, and will be in co-operation with AIME. The American Institute of Mining and Metallurgical Engineers has agreed to prepare some of the papers.

Attendance records were taken for the sessions in Toronto and Cleveland. There was a relatively large attendance at each session; however, the percentage of engineers who were actually employed by mining companies or metal manufacturers was relatively small. For this reason, the subcommittees have as their goal presentation of papers in such locations that the sessions will attract electrical engineers associated with the industries covered by each subcommittee.

The Metal Industries Subcommittee has a liaison representative working with American Institute of Steel Engineers. The Eastern Mining Subcommittee has a liaison representative working with the Underground Power Committee of the American Mining Congress. There is some joint effort on standards work.

Power Division

COMMITTEE ON CARRIER CURRENT

The Committee on Carrier Current sponsored two technical sessions at the Winter General Meeting (one of which was joint with the Committee on Relays), and plans are under way for a technical session at the Summer General Meeting. The West Coast members sponsored a technical session on carrier current and microwave applications at the Pacific General Meeting, and are undertaking the task of arranging for similar activities at the 1952 Pacific General Meeting.

The committee held two meetings during the year, which included a special session in New York, October 4–5, and a second meeting during the Winter General Meeting. It is hoped that the committee will be able to adopt a firm schedule of spring and fall meetings, at a location convenient to both East and West Coast personnel, in addition to those regularly scheduled during the Winter and Summer General Meetings.

Executive Subcommittee. This recently formed subcommittee consists of all past and present officers of the committee and the present subcommittee chairmen. The work of this subcommittee, specifically in regard to matters of policy, papers development, scheduling of technical sessions and committee meetings, membership, and so forth, has been instrumental in stimulating in the individual membership an increased awareness of, and interest in, the various problems and responsibilities of the main committee.

Subcommittee for Preparation of General Interest Paper on Carrier Current. The work of this subcommittee has resulted in the completion of a report, entitled "The Evolution of Power-Line Carrier," the first in a series of nontechnical, instructive articles of general interest rather than of technical value to the people in the work, which will be assembled in the form of a symposium for publication in a well-known engineering journal. In the future, the subcommittee will be concerned mainly with revising or modifying the article to co-ordinate with additional general interest articles in the course of preparation.

Subcommittee to Report on Application Guidance for Carrier Current. This recently reorganized subcommittee has devoted its time and attention to the assembling of technical information on various uses, performance, and limitations of power-line carrier channels as applied to power lines, and will recommend specific details of installation, data, and so forth, based on practical considerations and general information as received from operating organizations.

Subcommittee on Methods of Measurements and High-Frequency Characteristics of Power Equipment and Transmission Lines. This subcommittee is a consolidation of three older subcommittees having to do with measurements and characteristics, and was designed to eliminate duplication and overlapping of functions. The subcommittee had published one paper on methods of measurement in the carrier field, and has circulated a revision of the original presentation to the membership for comments. Also, data have been assembled, but not published, on transmission-line characteristics. These data have been reviewed, and a definite program has been developed to obtain and assemble additional information from new observations.

Subcommittee on Use of Microwave Equipment for Relaying, Telemetering, and Supervisory Control. In view of the considerable number of microwave channels installed, and being planned, throughout the United States, this subcommittee has been actively engaged in soliciting papers on experience with microwave installations, with the prospect of promoting a microwave session at the 1953 Winter General Meeting.

Subcommittee on Operating Experience With Carrier-Current Relaying Channels. The immediate job of this subcommittee has been to tabulate the results of a questionnaire which was sent to utilities throughout the United States and Canada. This work has consisted primarily of preparing the information for presentation.

Subcommittee for the Study of Long Life Tubes. The work of this subcommittee to date has resulted in a tabulation of ruggedized equivalents for tubes normally used in power-line carrier equipment, which will be submitted soon to all members for their use and comments. It has been decided, however, that the subcommittee should not ter-

minate with the completion of the present report, as there is a need for a working group in this field to study and report on this and allied subjects, such as better tube testing techniques, improved design of tube filaments, and so forth.

Subcommittee for the Preparation of a Carrier Current Bibliography. The bibliography of carrier-current, microwave, and low-frequency control applications is in draft form and has been circulated to the membership for comments and suggestions.

Other Activities. During the year, liaison representatives were appointed to the Committees on Relays, Standards, and Transformers.

Carrier current and microwave applications are experiencing an unusual expansion in the electrical utility field. This is due to the increased demand throughout the country for system and intersystem power transmission networks, with the increased need for high-speed relaying and automatic reclosure, and requirements for enlarged telemetering, supervisory, and communication systems.

The present rate of growth, in turn, presents a challenge in the carrier current field, where new applications are difficult to fit into the presently crowded carrier-frequency spectrum. This problem has been given considerable discussion by the committee, and has prompted the organization of a subcommittee to undertake the study of the most efficient use of the carrier-frequency spectrum, channel space, types of modulation, recommended bandwidths, and so on.

In addition to this problem, there is an increasing demand for improved equipment and component design, for example, coupling methods, broad-band trapping, optimum receiver selectivity and sensitivity, and types of modulation for various services and functions. Experience and knowledge appear to be lacking in connection with equipment, line, cable, and transmission systems which will determine carrier-frequency characteristics, particularly as to attenuation and noise conditions. A further study of these subjects, including the accumulation and assimilation of pertinent data, will be made by the Committee on Carrier Current.

COMMITTEE ON INSULATED CONDUCTORS

The Committee on Insulated Conductors is continuing its very active work in the field of insulated conductors, with two regular meetings each year. Sessions have been sponsored at each of three general meetings.

Recent years have brought a change from the use of low-pressure oil-filled cable to high-pressure pipe-type cable for the higher voltage tie lines. The committee has been actively engaged in sponsoring papers on the characteristics and ratings of pipe-type cables in order that the information be available to all interested.

Recognizing the importance of polyethylene as an insulating material, the committee sponsored a symposium on this subject at the Fall General Meeting. The success of this symposium resulted in obtaining approval to print all of the conference papers under one cover, this assembly of papers to be available during the first part of 1952.

Many other subjects are under review by the several subcommittees, and will result in technical papers during the coming year.

COMMITTEE ON POWER GENERATION

The committee held three meetings, one at each of three general meetings of the Institute. Subcommittees were active under the leadership of very able chairmen. Work for the year may be summarized as follows.

Prime Movers. A study was made of present-day trends in the size and design of electric generating equipment, including steam boilers, steam turbines, hydroelectric units, and gas turbines. Particular attention was paid to the use of higher temperatures and reheat in steam-electric generating plants, as well as the steady growth in gas turbine applications.

Station Design. This subcommittee organized a session on fire protection in electric stations, which was held during the Fall General Meeting. Two sessions are being organized, which will treat electrically driven station auxiliary supply and protection equipment including motor drive characteristics. The subcommittee is planning to sponsor these sessions at the Fall General Meeting. A session on the application of television to steam-electric power-plant operation is also being organized, and will be scheduled for the Fall General Meeting. A session on the design and operation of electric precipitators is being organized for the 1953 Winter General Meeting.

Speed Governing. The subcommittee is co-operating with the Control Subcommittee of the Committee on System Engineering in the joint sponsorship at the 1953 Winter General Meeting of two sessions on system load control and frequency regulations, with emphasis on the ability of turbines and boilers to accept load changes. This subcommittee is also maintaining close contact with the Joint ASME-AIEE Committee on Speed Governing Specifications through the chairman of this joint committee, who is a past chairman of the Committee on Power Generation. Two members of the Subcommittee on Speed Governing are also members of the Governor Specification Committee.

Excitation Systems. A session on excitation systems was organized and included in the program of the Winter General Meeting. Another session on excitation systems is being organized for inclusion in the program of the Summer General Meeting. Consideration was given to the desirability of initiating the preparation of standards for voltage regulators, and it was decided that such standards are needed, but that they should not be undertaken until certain other work is concluded, particularly the preparation of definitions applicable to excitation.

Application of Probability Methods. For some time, this subcommittee has been making a survey of forced outage experience with certain categories of boilers and steam turbines. A report is being prepared which will include tables giving the probabilities of outages for groups of from 2 to 65 units having various outage rates. The subcommittee is also preparing a manual which will coordinate the work of various authors pertaining to probability methods. The application of probability methods to station design and to the determination of system reserve should be much more extensive than it is, with emphasis on application to hydroelectric and mixed hydro-steam electric systems.

Hydroelectric Systems. The subcommittee organized sessions for the Summer General Meeting and the Winter General Meeting. A session is being organized for the 1953 Winter General Meeting, and a round-table conference meeting is being prepared for the Summer General Meeting. The latter will be devoted to answering questions regarding hydroelectric generation design and operation. Particular attention will be given questions originated by the Pacific Coast Subcommittee.

Pacific Coast. This subcommittee had an informal meeting at the Pacific General Meeting. Most of the attention in this area has been devoted to maintaining service during exceptionally heavy rain- and snowstorms with resulting floods. Attention also has been given operating troubles associated with the addition of new steam and hydroelectric generating capacity.

Other Activities. A paper on past and possible future trends in the development of the art of power generation is being sponsored for presentation at the Centennial of Engineering. Suggestions for the standardization of certain features of switchgear rating and design are being transmitted to the Standards Committee. Standards for the design of electric stations as prepared by insurance companies for use as a basis for insurance rates were reviewed and discussed with representatives of other interested committees.

COMMITTEE ON PROTECTIVE DEVICES

The Committee on Protective Devices sponsored a technical session at the Summer General Meeting, and a conference session at the Winter General Meeting. It held committee meetings during the Fall and Winter General meetings, and has scheduled a third to be held in Cleveland in May. The activities of the committee are primarily carried on by three subcommittees, whose reports follow.

Fault Limiting Devices. The working groups which prepared the three grounding guides on 1. Methods of Neutral Grounding of Transmission Systems, 2. Grounding of Synchronous Generating Systems, and 3. Application of Ground Fault Neutralizers, were reactivated last fall to put these guides in final form for Institute publication. At the present time, the original issues of these guides are out of print, and it is considered urgent that these be made available. It is expected that this work will be completed in the near future.

A working group has been working jointly with the Committee on Substations on a questionnaire on substation grounding. This questionnaire has been completed, and a preliminary report rendered. A complete report will follow at an early date.

A working group has been formed to review factors relative to the necessity for shunting protective devices on reactors used in feeders and neutrals. There is much work to be done on this activity before a report can be given.

Lightning Protective Devices. The Lightning Protective Devices Subcommittee has been occupied with the following projects: 1. Revision of Combined Standard for Valve and Expulsion Arresters, AIEE *28-A;* 2. Revision of Performance Charac-

teristics of Valve-Type Lightning Arresters; 3. Lightning Arrester Application Guide for the Protection of Substations and Stations; 4. Direct Stroke Protection of Substations and Stations; and 5. Protection of Aerial Cable.

Revision of the Combined Standard for Valve and Expulsion Arresters has included consideration of data made available to the industry by a joint subcommittee of the Committee on Transmission and Distribution and the Committee on Protective Devices, covering recovery voltage conditions which may be encountered in practice, in connection with determining the recovery voltage conditions under which power tests of expulsion-type arresters shall be made. Also, other items include the revision of arrester surge-current withstand tests, change of power-factor requirements of the test circuit for expulsion-type arresters, and revision of discharge-current and duty-cycle tests to include long duration surges.

A revised report is now in preparation, covering the Performance Characteristics of Valve-Type Lightning Arresters based on new reduced tolerances established by NEMA.

A preliminary report on the Lightning Arrester Application Guide for the Protection of Substations and Stations, which was introduced at the 1951 Summer General meeting, was presented again at the 1952 Winter General meeting to secure discussion principally by operating companies and to obtain field data based on operating experience. Efforts are now being directed to present the guide in final form to the industry. In this connection, supplementary information dealing with the extent and effectiveness of direct-stroke protection of substations and stations is being obtained through a questionnaire which has been circulated to various operating companies.

A study of protection of aerial cable is being undertaken in view of the increased interest in and use of this type of cable.

Co-ordination of Insulation. This subcommittee was formed primarily to keep the members of the main committee informed as to the progress that is made by AIEE Standards Co-ordinating Committee Number *8* and the Triple Joint Committee (EEI, AIEE, and NEMA) on the co-ordination of insulation. From this liaison, it is reported that, as a result of discussion of insulation levels, a preliminary report has been given approval by the three sponsor groups, and it is planned to present a joint progress report at the Summer General meeting.

The AIEE group has re-examined and reaffirmed the presently used impulse insulation levels in the subtransmission range of system voltages, 69 kv to 14.4 kv, and in the distribution range, 14.4 kv to 2.4 kv.

Two other items were reviewed. Several installations have been made using an impulse insulation level at 125 kv on a Y-connected 23-kv circuit with distributed grounding. The group declined to add this level to the standard list, because it was thought that the experience with it was insufficient. In the ASA Transformer Standards, there is an array of impulse insulation levels currently in use for dry-type transformers. The group also decided not to add these values to the standard list, because they were considered to be of limited, rather than general, application.

The group also reviewed the IEC proposals on insulation levels. The IEC values below 450-kv basic impulse insulation level are different from the United States values, but are the same at 450 kv and higher. The proposal to list two series to cover the lower range was accepted.

Impulse levels for nominal system voltages above 230 kv are currently under consideration.

COMMITTEE ON RELAYS

This committee held three meetings, and sponsored four technical sessions, two jointly with other committees. The technical activities of this committee were carried on through a number of project committees which were appointed to fulfill specific assignments. In order to increase the interest and co-operation of Pacific Coast members, a Pacific Coast Subcommittee is being organized. Following are the reports of the various project committees.

Bibliography of Relay Literature. Work on the Relay Bibliography for 1950 has been completed. Publication is expected by May 1952. The committee will continue to maintain an up-to-date bibliography in future years.

Co-ordination of Construction and Protection of Distribution Circuits. This project committee is a joint working group of the Committee on Relays, the Distribution Subcommittee, and the Edison Electric Institute Transmission and Distribution Committee.

Having presented its first report to the Institute based on operating data for the year 1949, this committee is continuing its work with a similar study of data for 1950 and 1951. In the report for 1949, several exhibits were omitted because of inconclusive data. However, it is hoped that the 1950 and 1951 data will clarify these points sufficiently to warrant inclusion in the next report.

Standards for Power Relays. The chairmanship of this committee changed hands within the last year. This was necessary because of duplicate responsibilities on a NEMA committee which was established to investigate similar problems. Under the new chairman, the committee plans on developing general performance requirements of power relays. It is hoped that this information can be worked into a form satisfactory for inclusion in ASA Standard *C-37.1*, "Relays Associated With Electric Power Apparatus."

Transmission-Line Protection. The Project Committee on Transmission-Line Relaying is endeavoring to develop further material on ground relaying and backup relaying for incorporation in its final report. A *Transactions*-type paper on ground relaying has been submitted. Replies to the questionnaire on backup practice are being analyzed, and a conference paper will be prepared covering the analysis. Both papers will be presented at the Summer General Meeting. It is hoped that the conference paper will stimulate further discussion and that from it a *Transactions* paper can be prepared. With this, sufficient material should have been developed for the final committee report.

Electronic Relay Applications. This committee will continue to follow the developments in this field, including the relatively new microwave relaying. It is hoped that a report will be available within the next year on the operating experience obtained with an installation of electronic distance relays.

Co-ordination of Relay Protection of Industrial Power Systems With Utility Systems. Active interest in continuing this project was evinced at an all-day meeting in Detroit. It was agreed that the major problem at present is to make the industrial user aware of the need for well-engineered relaying and the benefits to be derived from it. To consummate such a plan, the membership was increased by adding two members from the Committee on Relays and five from the Committee on Industrial Power Systems. The project committee welcomed an opportunity to contribute a chapter on relaying to the revised "Red Book." With its wide distribution, this book should do much to make management of industrial plants conscious of good relaying. The initial draft of this chapter is now being written.

Remote Tripping Schemes. A questionnaire on this subject was sent out in April 1950. Four schemes, grounding switches, back-feed tripping, transferred tripping, and remote tripping by space radio, were defined and specific questions asked about each.

A report was made at the May 1951 meeting covering the replies to date. An attempt was made to get further replies, but without much success. It is planned to hold a meeting in conjunction with the Committee on Relays meeting in May to examine the results and determine whether sufficient pertinent data are on hand to warrant a formal report.

Pilot Wires. About a year ago, the committee circulated a questionnaire to obtain information from utility companies relative to their operating experience with pilot wires used for protective relaying. Approximately 40 answers have been received to this questionnaire. The data obtained from these questionnaires are now being tabulated, and a report will be issued in the near future.

Test Methods. Because of the interest generated by the Conference on Relay Test Methods at the 1951 Fall General Meeting, the project committee plans to continue with similar activities, including a study of design and facilities for testing laboratories, and the preparation of a Relay Test Code.

Effect of Vibration and Shock on Relays. Lack of a chairman has temporarily stopped the progress of this project committee.

Joint and Associated Projects. The committee participates in the activities of the Instrument Transformer Subcommittee of the Committee on Transformers, with special attention to the relaying performance of current transformers and the transient performance of capacitance potential devices. The Committee on Relays has maintained close co-ordination with the activities of the Committee on Carrier Current on items of joint interest.

COMMITTEE ON ROTATING MACHINERY

Interest in rotating machinery continues at a high level. Many papers and numerous technical sessions have been sponsored during the past year, and many are planned. Two

new subcommittees have been formed and three working groups set up for specific purposes.

A new code for testing carbon brushes has been completed by the Joint Subcommittee on Carbon Brushes, and is now in process of letter ballot. Other test codes and application guides are in process.

A meeting of the committee was held at the Winter General Meeting. There have been two meetings of the Administrative Subcommittee, one in Cleveland, and one in New York; a third is planned for Minneapolis. Most of the work is carried on in subcommittees, which have held a number of meetings, and by correspondence and telephone.

Test-Code Subcommittee. This committee has co-ordinated the preparation of two test codes, the Carbon Brush Test Code, and a revision of the Polyphase Test Code. The chairman is a liaison representative on the Subcommittee on a Master Test Code for Speed Measurements, which was organized by the Committee on Instruments and Measurements. Revisions of other test codes are contemplated to make them suitable for incorporation directly into American Standards Association Standards.

Insulation Subcommittee. Interest in this subject continues at a high level. One working group has made considerable progress in the preparation of a guide for maintenance testing of high-voltage machine insulation. A second working group is attempting to develop test methods for the functional evaluation of insulation. These studies may lead to eventual redefinition of classes of insulation now in AIEE Standards. Both subjects were discussed in technical sessions at the Winter General Meeting.

Induction Machinery Subcommittee. The Polyphase Test Code has been revised and sent out for letter ballot. A joint symposium on powerhouse auxiliaries is being planned in co-operation with the Committee on Power Generation for the New Orleans meeting. The subcommittee is planning a 2-session symposium on double-cage induction motors at the Toledo meeting. Another project now under way is the preparation of an application guide for induction motors.

D-C Machinery Subcommittee. A technical session, principally on the transient performance of d-c machines, was sponsored at the Winter General Meeting. The subcommittee is tentatively planning a session on maintenance of electric machines, in co-operation with other interested subcommittees.

Single-Phase and Fractional-Horsepower Subcommittee. A successful technical conference on small motor applications was held in Dayton, Ohio, October 11 and 12, 1951, with approximately 175 in attendance. The Single-Phase Test Code is being revised.

A report was prepared by the subcommittee favoring general adoption of the applied-detector method of temperature measurement; this was referred to Standards Co-ordinating Committee *4*. A session on thermal protection of small motors is planned for the near future.

Synchronous Machinery Subcommittee. A technical session was sponsored at the Winter General Meeting. A symposium on single-phase short circuits is tentatively planned. The subcommittee also expects to assist in the symposium on powerhouse auxiliaries. A working group has been formed to prepare an operating guide for synchronous machinery.

Electric Coupling Subcommittee. This is a new subcommittee. It is very active in promoting papers and technical sessions in its field. It has prepared a bibliography, and numerous definitions for its assigned scope, and is currently active on methods of rating electric couplings.

Bibliography and Publicity Subcommittee. This is a new subcommittee. It supplies committee notes and progress reviews for *Electrical Engineering*. It has recommended revision of the Machinery Bibliography at 5-year intervals.

Working Groups. Three working groups have been set up by the committee as follows:

1. Per-unit definitions. This group is attempting to set up definitions of per-unit quantities for synchronous and asynchronous machines. Possibility of defining these for d-c machines is being considered.
2. Nomenclature for induction machines. This group is attempting to develop standard symbols for the constants of induction machinery.
3. Co-operation with engineering schools. This group has been set up to determine what can be done to stimulate more interest in rotating machinery among students in engineering colleges. This group includes a liaison member from the Committee on Education.

COMMITTEE ON SUBSTATIONS

The status of the projects on which work is in progress in the subcommittees and working groups of this committee is described in the following:

Working Group on Device Function Numbers. No activity necessary during the past year.

Working Group on Rectifier Switchgear. Some work in connection with ASA Standards *C34.1—1949* for Pool Cathode Mercury-Arc Power Converters.

Automatic and Supervisory Control Subcommittee. A questionnaire has been prepared on supervisory control to determine present practice, and so forth.

Substation Grounding Practices Working Group. Has completed initial part of its project, which culminated in a preliminary report presented at the Winter General Meeting, and is now planning on preparing a final report with recommended practices.

General. Other projects now being worked on include: "Basic 1-Line Diagrams for Substations"; "Safety Considerations in Substations"; "Recommended Minimum Clearances in Substations"; and "Circuit Breakers Versus Reclosing Fuses for Substation Application." All should result in reports or papers within the year.

Working Group on Basic Structural Design completed its work with the presentation of a formal report, and was dismissed.

The Committee on Substations sponsored a technical session at the Winter General Meeting, and held two general committee meetings during the year.

COMMITTEE ON SWITCHGEAR

This committee held two meetings during the last year, which were well-attended. Numerous additional meetings of the subcommittees were also held.

During the year, the main project of revising all AIEE switchgear standards has been completed, and it is thought that, with the issuance of those still to be acted upon by the Standards Committee, these standards will be up to date and more useful than in the past. Standards *20* and *27* were issued. Standards *22* and *25* have been approved, and will be issued shortly. Standard *50* has been revised, and is now in the hands of the Standards Committee for action. Also, before that committee for action is a proposed revision of ASA Standards *C37.4*, *C37.5*, and *C37.9*. This revision has been prepared in co-operation with the AIEE-EEI-NEMA Joint Committee on Power Circuit Breakers, as well as other interested organizations; and if approved, will be transmitted to ASA for the approval of the ASA *C37* Subcommittee. It is hoped this revision of the *C37* Standards can be consummated in the near future.

At the Winter General Meeting, the Committee on Switchgear sponsored a session of great general interest on the subject of the correct methods of rating circuit breakers for interrupting capacity. This subject has been a matter of considerable discussion during the last few years, particularly in view of the attempts being made by IEC to establish an international standard. To accomplish this, the great divergence between European and American standards should be reconciled, and a study of the fundamental factors to be taken into account should be reviewed. It is thought this session, together with the discussions on the papers presented, laid a sound basis for approaching the problem. The Subcommittee on Power Circuit Breakers has been assigned the project of carrying on a study of this subject and preparing a committee report, giving recommendations. A working group under this subcommittee has been appointed, and is now engaged in its consideration. It is planned to have the work of this group completed by early fall.

The other subcommittees have been active in considering various matters, which may eventually result in some revisions of the present standards. Among the matters being investigated are the temperature rises encountered in outdoor switchgear, icing troubles encountered on outdoor disconnecting switches, and the desirability of change in the standard duty cycle for power circuit breakers.

The desirability of some standardization on network protectors is still under consideration by the Network Protector Subcommittee.

Altogether, it is thought that the Committee on Switchgear has accomplished a great deal in the past year. The members have shown a commendable interest in the work of the committee, and some of the matters being considered for future action are of great importance to the industry.

COMMITTEE ON SYSTEM ENGINEERING

This committee, which is entering its sixth year of existence, met three times during the

past year. Its technical program began at the Summer General Meeting with a conference session on "System Voltage Control." At the Fall General Meeting, the committee sponsored a double session, at which six formal papers and one conference paper were presented, on the subject of "Economic Comparison of Alternate Facilities." At the Winter General Meeting, one session was sponsored. Five formal papers and one conference paper were presented, on the general subject of "System Planning."

With the dissolution in January of the Interconnection Contracts Subcommittee, the committee's subcommittee organization has been reduced to the following five: 1. Administrative; 2. System Planning; 3. System Operation; 4. System Economic; 5. System Controls.

For the Summer General Meeting, it is planned to sponsor a session of five papers on the general subject of "System Operation." Subsequent sessions are being planned to deal with methods of load forecasting, and with the general problem of electric system controls. This latter subject will be jointly sponsored by the System Controls Subcommittee and the Special Governing Subcommittee of the Committee on Power Generation, and will probably require two sessions for presentation.

COMMITTEE ON TRANSFORMERS

The committee was reorganized to form five standing subcommittees. These are: 1. Subcommittee on Insulation Tests; 2. Subcommittee on Insulation Fluids; 3. Subcommittee on Insulation Life; 4. Subcommittee on Magnetic Circuit Behavior; and 5. Subcommittee on Performance Characteristics. Under these various headings, specific problems are to be delegated to working groups as the nature of the work requires.

Subcommittee on Insulation Tests. This year, proposals for changes both in the ASA Standards and Test Code for various dielectric tests have been approved by the committee, and forwarded to the Standards Committee. Changes in tests on current limiting reactors are still being considered by the committee. These changes have been in the nature of refinements to present methods and values. Radical changes involving reconsideration of fundamental requirements and the determination of basic insulation properties to determine what might be needed to meet the requirements have been proposed several times. Two working groups have this matter under consideration.

Changes in the arrangement of the tables for dielectric tests are necessary, but are affected by the content of the tables. The disassociation of application data from the main table is proposed and this complicates the problem. Temporary solutions to meet conditions as they are now may be required.

The question of insulation power factor tests has been brought up, but a final solution has not been obtained.

Subcommittee on Insulating Fluids. This subcommittee is undertaking a project on methods and costs of reclaiming insulating oils.

Subcommittee on Insulation Life. It was found that the methods of making heat runs were somewhat questionable, and a thorough study of this question was undertaken. Proposed changes in the making of heat runs for oil-insulated transformers have been approved by the Committee on Transformers, and forwarded to the Standards Committee. Study on the procedure for dry-type transformers is in progress.

A joint laboratory investigation on the temperature limits for Class-*B* and Class-*H* insulation has been in progress. Meanwhile, present temperature limits are being extended until 1953.

Subcommittee on Magnetic Circuit Behavior. Noise, its measurement, and means of reducing it are being studied by a working group. It is a very difficult and complicated subject.

Magnetizing inrush currents and their effects on relays have been studied, and some work on fault currents in small parts of transformer windings has been done, also with reference to relaying problems.

Subcommittee on Performance Characteristics. The revision of the standards for current limiting reactors is being studied, and will be completed soon.

Guides for Operation and Maintenance of Dry-Type Transformers were approved by the Committee on Transformers, and submitted to the Standards Committee.

COMMITTEE ON TRANSMISSION AND DISTRIBUTION

The electric power industry's expansion of transmission facilities is reflected in the continued activity and diversity of subjects now being considered by the committee. All five of its subcommittees have sponsored many papers of broad and detailed interest.

The Capacitor Subcommittee published a 20-page bibliography of material dealing with capacitors over a 20-year period which is now available through the AIEE headquarters. This subcommittee has also published "Guides for Short-Time 60-Cycle Overvoltage Operation of Power Capacitors," which has been used as a basis for revision and extension of the ASA standard for capacitors. Several papers have been presented which deal with the design, application, test, and operating experience of high-voltage series capacitors, an important development in the field of high-voltage long-distance transmission.

In the distribution field, a session was held at the Winter General Meeting on the use of weatherproof wire and the advantages of voltages above 5,000 volts. A progress report was also presented by a joint AIEE-EEI Working Group on Co-ordination and Construction and Protection of Distribution Circuits. Additional papers are also planned for the Summer General Meeting.

The General Systems Subcommittee has completed its line outage survey, which has been summarized in a technical paper presented at the Winter General Meeting by a Joint AIEE-EEI Subject Committee on Line Outages. This report covers 236,666 mile-years of operating experience. At this same meeting, a joint conference paper on distribution circuit recovery voltages, sponsored by the General Systems Subcommittee and the Lightning Protective Devices Subcommittee, was presented. Papers have been presented describing more accurate methods for analyzing faults and short-circuit currents. The development and use of network analyzer analogues for untransposed transmission circuits and for calculating stability swing curves have been presented, as well as new methods for determining transmission-line constants.

The Towers, Poles, and Conductors Subcommittee co-operated with the General Systems Subcommittee in sponsoring a conference of six papers dealing with sleet melting practices. A great deal of interest was shown in this subject, and additional papers are planned for the Summer General Meeting.

In the lightning and insulator field, the studies of impulse characteristics of insulating material and gaps are being continued. Corona, radio noise, lightning protection, and insulation co-ordination subjects found real interest in the continued efforts to reduce the cost and improve the performance characteristic of transmission circuits.

Papers on the design of transmission circuits, as well as their operating characteristics, were sponsored by the Towers, Poles, and Conductors Subcommittee. Subjects covered include sag and tension calculations, the transposition of overhead lines, and the particular operating experiences of systems before and after changes in design.

Papers are planned which will deal with sleet melting, design of tower lines, and stability for the Summer General Meeting. Also under the joint sponsorship of the Committee on Transmission and Distribution and the Committee on System Engineering, papers are planned which will deal with economy loading of large interconnected systems.

The main committee meets about twice a year, at which times the activities and policy of the committee are reviewed. The subcommittees are responsible for all technical projects, and draw upon the Institute membership for the specialized personnel required by the subject committees and working groups.

Science and Electronics Division

SCIENCE AND ELECTRONICS DIVISION COMMITTEE

The Science and Electronics Division and its constituent committees have directed major efforts toward keeping AIEE in the forefront of the rapidly expanding and proliferating field of electronics. A particular purpose has been to develop and maintain an active interest in AIEE on the part of the increasing numbers of electronic engineers. In working toward these objectives, the division has enjoyed the wholehearted co-operation of the Board of Directors and the several committees with which it is associated.

The creation of the Committee on Magnetic Amplifiers, and the merger of two previous committees into a new Committee on Electrical Techniques in Medicine and Biology, both of which became effective in the latter half of the previous administrative year, have resulted in strong and active committees in their respective fields. The subject of dielectric amplifiers, in which interest is now developing, is for the present being handled by two groups, one under the Committee on Magnetic Amplifiers, and the other under the Committee on Electronics. The Joint AIEE-IRE Committee on High-Frequency Measurements, which was estab-

lished in 1950 to handle problems of mutual interest, has been functioning actively ever since. Under the sponsorship of this committee, two conferences on high-frequency measurements have been held, and another is planned for early 1953.

COMMITTEE ON BASIC SCIENCES

Since the last report, the Committee on Basic Sciences and its subcommittees have sponsored sessions as follows: Summer General Meeting, one; Fall General Meeting, three; Winter General Meeting, nine.

Unfortunately, the establishment of the Subcommittee on Defense mentioned in the previous report was hindered through the lack of co-operation of the federal agency concerned. The matter is, however, still pending, and it is hoped that the value of such co-operation will be recognized by that federal agency and that the Subcommittee on Defense will be able to do its share in furthering the defense efforts of our nation.

A new subcommittee of the Committee on Basic Sciences was established under the name of "Subcommittee on Basic Concepts." The scope will be published in the 1952 Year Book.

The various subcommittees of the Committee on Basic Sciences have been active in acquainting the engineering profession with new developments in the fields of physics, chemistry, and mathematics. Following is a summary of the activities of the subcommittees.

Subcommittee on Applied Mathematics. Announcement was made in the July 1951 issue of *Electrical Engineering* that the Subcommittee on Applied Mathematics is prepared to help the profession in the solution of various mathematical problems. Several problems have been submitted to the subcommittee since this announcement appeared. These were referred to experts in the field. Some of the problems already have been solved. The solution of other problems is pending. The subcommittee thinks it is rendering a service to the profession in sponsoring this project, but hopes that more engineers will take advantage of its offer.

Subcommittee on Magnetics. This subcommittee sponsored two symposia at the Winter General Meeting, one on permanent magnets, consisting of six conference papers, and the other on high-permeability magnetic materials, with four conference papers.

Subcommittee on Electric Circuit Theory. During the Fall General Meeting, the subcommittee sponsored a symposium on filter design. Four conference papers covered various aspects of the design of filters.

Subcommittee on Electrical Properties of Gases. At a conference on fundamental processes in gas discharge tubes held during the Winter General Meeting, four conference papers were presented and discussed.

Subcommittee on Dielectrics. This subcommittee sponsored one session of six papers at the Fall General Meeting, and two sessions, each consisting of five conference papers, at the Winter General Meeting.

Subcommittee on Semiconductors and Transistors. This subcommittee sponsored one symposium consisting of six conference papers on "Germanium Rectifiers and Transistors" during the Winter General Meeting.

Subcommittee on Energy Sources. This subcommittee sponsored one conference at the Winter General Meeting, involving two conference papers.

General. All these conferences and symposia were well-attended and well-received as attested by the large attendance and the lively discussion of the papers. The principal object of these conferences and symposia is to acquaint the profession with modern developments in the various basic sciences. This object was carried out very effectively through the medium of papers and discussions.

COMMITTEE ON COMPUTING DEVICES

Marked progress was made in the computing field during the last year. Several major large-scale digital electronic computing machines were completed and put in service during the year, both in the United States and England. A considerable number of electronic analogue computers and card-controlled electronic sequence calculators were placed in use, and a number of new computers in the smaller digital and analogue machine class were developed by various organizations entering the computer field. Many of the new machines were applied to dynamic problems of control and design of military equipment, new forms of power plants, and the like. The chemical industry has found increasing use for computing services, and a symposium of a dozen papers was printed in one of the chemical journals during the year. In technical progress, the completion of three machines using varying forms of electrostatic storage and the development of a special cathode-ray tube for the Williams type of electrostatic storage marked the advent of very much higher speeds of computation and means of storing many more numbers than previously.

In recognition of the rapid growth of large-scale digital computers, and following a very successful conference on electron tubes for computers, which was held in Atlantic City, N. J., in December 1950, a Joint AIEE-IRE Computer Conference Committee was to explore the possibility of holding further joint conferences in this field. The joint committee consists of members appointed by the AIEE Committee on Computing Devices and by the IRE Electronic Computers Committee (now by the IRE Professional Group on Electronic Computers). The first act of the joint committee was to arrange a conference in Philadelphia, in December 1951, to discuss the characteristics and performance of ten working large-scale electronic digital computers. The Association for Computing Machinery (ACM) also participated in planning the conference, but the engineering point of view of the AIEE and IRE has been emphasized over the somewhat mathematical approach of the ACM. This 3-day meeting was most successful, and an attendance of 877 engineers gives a measure of the rapidly expanding interest in computing. The proceedings of this conference have been published by the AIEE in a 114-page report, which in itself represents an important contribution to the literature.

Through the Joint Computer Conference Committee, the Committee on Computing Devices is sponsoring a conference on input-output components and techniques, which will be held in New York, N. Y., in December 1952, and a conference on the evaluation of small semiportable electronic computers, to be held early next spring on the West Coast.

Another activity of the Committee on Computing Devices has been to circulate for review and preparation of 1- or 2-sentence abstracts of the principal references a mimeographed draft of a bibliography on computing devices which was prepared by the Computer Bibliography Subcommittee. It is expected that this bibliography will appear this fall as an AIEE special publication.

The Subcommittees on Analogue Computers and Digital Computers have functioned primarily in reviewing papers and arranging sessions at technical meetings. Two *ad hoc* subcommittees have been active, one to review the past AIEE coverage of the computing devices field, and another to compile a list of persons active in the computing field who may be invited to committee membership as the work load indicates.

A Subcommittee on Computer Comparisons is being formed to determine combinations of simple characteristics which are most significant in describing the over-all performance of a large computer. This point of view is somewhat different from the usual standards approach—the large computers are so complex that the simple characteristics are misleading if used directly as yardsticks in comparing several computers. These simple characteristics are usually the subject of standards definitions.

The committee has continued to serve as a means of scheduling for presentation at general and District meetings submitted papers on small and large analogue and digital computers. In addition, it sponsored one highly successful session at the Winter General Meeting, in which four papers were presented; three of these papers have since been accepted for *Transactions* publication. A history-and-forecast paper on computing devices is planned for the Centennial of Engineering.

COMMITTEE ON ELECTRICAL TECHNIQUES IN MEDICINE AND BIOLOGY

The Board of Directors last year authorized the appointment of the Committee on Electrical Techniques in Medicine and Biology to combine the work previously distributed between the Committee on Therapeutics and the Subcommittee on Electrical Aids to Medicine. The committee membership for 1951–52 includes most of those who were members of the committee and subcommittee which were dissolved.

The new committee undertook the preparation of the program for the fourth annual Conference on Electronic Instrumentation and Nucleonics in Medicine. Five sessions were scheduled and presented on January 7 and 8. Approximately 250 attended these sessions.

The committee met in New York in January, and discussed long-term plans. The committee also decided to have two sessions during the Summer General Meeting, one jointly with the Committee on Safety. The programs of these two sessions are practically complete. A tentative plan for a session at the Pacific General Meeting is being considered.

The committee arranged for the release of a description of committee activities and an invitation to others who might be in-

terested in the same fields to propose co-operative programs.

COMMITTEE ON ELECTRONIC POWER CONVERTERS

At the start of the administrative year, the subcommittees were rearranged. The Rectifying Devices Subcommittee was discontinued. The Application Subcommittee was changed to the Mercury-Arc Converter Subcommittee. The Transformer Subcommittee was consolidated with the Circuits Subcommittee. The present subcommittees are as follows: Administrative, Mercury-Arc Converter, Hot-Cathode Converter, Mechanical Rectifier, Electronic Converter Circuits, Papers and Speakers, and West Coast.

Most of the special tasks undertaken by this committee have been or soon will be completed. Because of the limited number of engineers engaged in the technical phases of electronic power conversion, and the pressure exerted on them by the current expansion of rectifier installations, it has been difficult to conduct the usual number of technical sessions and papers.

The full committee met January 22, in New York, to outline plans for the remainder of the year. Some of the subcommittees held meetings during the year.

Progress on the various committee projects has been as follows.

Bibliography on Electronic Power Converters. The Subcommittee on Papers and Speakers prepared and distributed a 3-year supplement to the bibliography covering the years of 1948–50 inclusive.

Standards for Hot-Cathode Power Converters. The Subcommittee on Hot-Cathode Power Converters has prepared and approved the standards, and has presented them to the main committee for its approval.

Survey of Operation of Mercury-Arc Rectifiers. The compilation of this survey, started by the Applications Subcommittee, has been completed, and arrangements made for publication and distribution in pamphlet form.

Report on Rectifier Cooling and Corrosion Problems. A working group is preparing a report summarizing the available information on rectifier cooling and corrosion problems, and outlining recommended practice. A preliminary report was presented at the May technical conference, and the final report will be submitted as a *Transactions* paper shortly thereafter.

West Coast Subcommittee. This subcommittee, continuing to serve rectifier users on the West Coast, held a very successful session at the Pacific General Meeting.

Mechanical Rectifier Subcommittee. This subcommittee has been requested to preface a glossary of terms and definitions of components, circuits, functions, and properties of mechanical rectifiers for submission to the main committee.

Conference on Power Tubes and Applications. A 2-day technical conference, sponsored by this committee and the Electron Tubes Subcommittee, was held in Pittsburgh on May 19 and 20, presenting a total of 22 papers. One of the features of the conference was a panel discussion of all rectifier problems for the special benefit of users and students.

COMMITTEE ON ELECTRONICS

The Committee on Electronics acts as a clearing house for all matters pertaining to electronics, and works through subcommittees and working groups. Therefore, the report consists of the reports from the subcommittees.

Subcommittee on Electrostatic Processes. Work has been continued on standards for electric power supplies used in electrostatic precipitation. The section on transformers is now under study. It is planned to obtain help from specialists outside the subcommittee. The January 1952 subcommittee meeting was devoted largely to the standards work.

The other main activity is that of obtaining suitable technical papers. Four papers on electrostatic processes are available for the Summer General Meeting, and two more have been promised for a later meeting.

It is planned to hold two meetings of the subcommittee next June for work on papers and standards.

Subcommittee on High-Frequency Conductors, Cables, and Connectors. This subcommittee has not been particularly active. There has been liaison with other organizations. The subcommittee has not had a meeting, and most of the work has been by correspondence. There has been some activity in connection with technical papers.

Subcommittee on Induction and Dielectric Heating. During the past year, two major achievements in the induction and dielectric field have been accomplished. The first of these pertains to the completion of standards for this industry by the Induction and Dielectric Subcommittee of the Committee on Electric Heating. The second was the successful sponsoring of the first Induction and Dielectric Heating Conference.

The standards which have been completed cover all phases including definitions, types of equipment, selection of equipment, installation, operation, and maintenance of equipment. It is a very comprehensive work which is now up for final approval by the Standards Committee.

The Induction and Dielectric Heating Conference held in Cleveland, Ohio, February 19–20, 1952, was the first conference ever sponsored to deal exclusively with induction and dielectric heating problems. The program included 14 papers stressing new uses for high-frequency heating of all types and an open forum discussion. Its success was proved by the many enthusiastic comments received.

Subcommittee on Infrared Applications. The work of the Subcommittee on Infrared Applications has been at almost a standstill during the past year. Some effort was made to report on standard nomenclature in infrared.

Subcommittee on Electronic Aids to Navigation. This subcommittee continues to be a 1-man liaison enterprise, in which the chairman of the AIEE subcommittee is also vice-chairman of the corresponding IRE committee. In brief, the IRE group has very recently completed a revision of its basic list of terms and definitions appropriate to electronic navigation. As soon as IRE publication is scheduled, the AIEE Committee on Electronics will be notified in order that the list may be brought to the attention of AIEE members by means of a reference, an abstract, or other appropriate means. The IRE committee is now engaged in analysis of a supplementary list of pulse-terms and definitions. It has also received, from its Subcommittee on Direction Finders, an extensive third provisional draft covering recommended measurement procedures.

Subcommittee on Electronic Semiconductor Devices. Although no full meetings of this subcommittee are planned in the near future, it was active in sponsoring a session on semiconductor devices at the Winter General Meeting, in co-operation with the Semiconductor Subcommittee of the Committee on Basic Sciences. For the past few months, major efforts have been devoted to organizing the joint AIEE-IRE semiconductor symposium to be held at the University of Illinois, June 19 and 20.

Arrangements have been made with the IRE Committee on Semiconductors to instigate a joint effort in the line of standardization, test procedures, and nomenclature, starting at the latter part of next month. The proposal for joint action has been favorably received in the IRE group. A survey of membership has been initiated to be sure that all segments of industry are represented.

Subcommittee on Electronic Education. The subcommittee held one meeting during the year, at which electronic education for students majoring in mechanical, chemical, and other areas of engineering was discussed. This is rapidly becoming an important area, and it is hoped will lead to a program at the 1953 Winter General Meeting.

Subcommittee on Electronic Systems Engineering. It is the responsibility of this subcommittee to promote the early presentation of material on electronic systems engineering that has for its origin in the requirements of the military, and is, or can be, declassified for presentation to the professional societies. Possible papers are reviewed at an early stage, and assistance is offered the authors in the formulation of the material.

Subcommittee on Papers and Meetings. This subcommittee routes the manuscripts sent from headquarters for review to the appropriate subcommittee, or to selected Institute members.

During the past year, a special effort has been made to aid scheduling of approved papers available at headquarters. This has been aided by the policy of increasing the presentation of papers at the Fall General Meeting and District meetings. The subcommittee also aids the chairman of the main committee in organizing technical sessions not directly in the field of some one subcommittee.

A memorandum on committee procedures for the handling of papers and planning of sessions was recently compiled and distributed.

Subcommittee on Electron Tubes. The eight working groups within the subcommittee structure have been completely reorganized, and work is now under way towards the promulgation of standards on electron tubes of all types; this work being undertaken in such a manner that proposed standards will not conflict with those of other groups or professional societies.

To insure against duplication of effort, liaison representatives have been appointed from the Committees on Instruments and Measurements and Electronic Power Converters; Joint Electron Tube Engineering Council Committee on Tubes; American Physical Society; and IRE Committee on Electron Tubes and Solid States Devices.

The Working Group on Gas-Filled Thermionic and Cold Cathode Tubes and Phototubes is preparing definitions of terms and test methods on tubes in that field of activity for standardization.

The Working Group on Cathode-Ray Tubes is preparing suggested standards of a similar nature on cathode-ray tubes.

A group for the preparation of standards on mercury-pool cathode tubes has been organized.

Another working group is preparing standards on small tubes for entertainment use.

The standards program on electron tubes is expected to be concluded before the end of the present year, at which time the standards developed will be submitted to the Committee on Electronics and to the Standards Committee for final approval.

The Committee on Electronics, jointly with the Committee on Electronic Power Converters, is sponsoring a Technical Conference on Rectifying Devices to be held in Pittsburgh, Pa., May 19–20, 1952.

Subcommittee on Nuclear Instruments. A Scintillation Counter Symposium was organized for January 29 and 30. This symposium was sponsored jointly by AIEE, IRE, the National Bureau of Standards, and the Atomic Energy Commission. Sixteen invited papers and approximately 25 contributed papers were presented.

Subcommittee on Dielectric Amplifiers. This subcommittee was organized at the Winter General Meeting to take care of the new fast developing field in dielectric amplifiers, which are a high-frequency counterpart of magnetic amplifiers, except that they use the dielectric field instead of the magnetic field as the basis of their operation.

COMMITTEE ON INSTRUMENTS AND MEASUREMENTS

The responsibilities of this committee are largely horizontal, cutting across boundaries and being involved with the entire gamut of the electrical industry. As in previous years, this basic fact has made the activities of the committee quite varied.

To maintain the broad front, the membership is approximately equally divided among those affiliated with educational institutions, laboratories, both government and industrial, utilities, and manufacturers. This distribution has been most helpful in obtaining technical paper reviews from an industry cross section applicable to each measurement problem.

Again, because of this broad front the committee has a vice-chairman for the East and one for the West, and a secretary in each area. While the eastern officers are both able to attend meetings and accomplish the major part of the work, those in the western area have broadened the coverage by sponsoring the many papers and activities in the Pacific Coast area. Because of the bulk of the work to be accomplished, paper reviews are handled by the respective vice-chairmen, who thereby become familiar with the activities and are able to function better when advanced to chairman status. This arrangement also divides the load and allows the chairman to retain an objective control of the activities.

The first committee meeting of the year was held October 2, 1951, at headquarters. A luncheon meeting was held during the Winter General Meeting. A luncheon meeting is also planned for the Summer General Meeting.

The Subcommittee on Geophysical Instruments is a new subcommittee formed for the purpose of sponsoring such activities as would seem pertinent under this subject.

Subcommittee on Organization, at the Fall General Meeting, reported on a new structure which was approved unanimously. Technicalities in terminology were somewhat involved, but have largely been resolved. The necessary regrouping is reasonably well in hand, and the agenda for the winter committee meeting was in the new format for trial. It is believed that the subcommittee grouping will be placed on a modified basis for the new working year starting August 1, 1952.

Subcommittee on Review of Standard 4, Measurement of Test Voltage in Dielectric Tests has submitted the final draft of the proposed new standard to the committee. After approval by this committee, it will be processed through appropriate channels.

Subcommittee on Watt-Hour Meters has submitted a final draft of a bibliography on watt-hour meters.

Subcommittee on Definitions indicated that the items in Group 30 are about ready to be submitted to the sectional committee for final approval.

Subcommittee on Dielectric Measurements in the Field has started the preparation of a test guide for such measurements. At the Winter General Meeting, this subcommittee divided the project into sections, and assigned working groups so that the first draft is now under way.

Subcommittee on Recording and Controlling Instruments is planning a technical conference on recording and controlling instruments to be held in Philadelphia this fall.

Subcommittee on High-Frequency Measurements sponsored a session at the National Electronics Conference last fall, which was well-attended.

Subcommittee on the Marking of Varmeters and Related Instruments, having published its report in *Electrical Engineering*, is continued in a stand-by capacity. Discussion by mail is still continuing with the committee, and a supplementary report of these discussions may be published within the year.

Subcommittee on Co-operation With the Instrument Society of America (ISA) sponsored six papers in a geophysical technical session at the Houston, Tex., 1951, Instrument Conference of the ISA. Plans are being made to sponsor a group of papers at the 1952 meeting of the ISA in Cleveland, Ohio, September 8–12.

Subcommittee on Master Test Code for Power Measurements reports that the third draft of the code has been completed and reviewed, and is ready for advancement to the main committee for review, comment, and the usual trial period.

Subcommittee on Industrial Spectroscopy has pointed out that the name "emission spectroscopy" is a better name for its activities. It is expected that this work will be broadened into both emission and absorptive spectroscopy in the near future.

Subcommittee on Master Test Code for Speed Measurements has mapped out the items to be covered in this code, a tentative outline has been produced, and preliminary items are being written for incorporation in an initial draft.

Subcommittee on Navigation Instruments has held a preliminary meeting, and has investigated the work of others in this field; a study of the scope to be covered is in hand.

Joint Subcommittee on Telemetering is planning a technical conference on the subject to be held on the West Coast in May. There appears to be a rather high degree of interest in this subject in the California area.

Joint Subcommittee on Electronic Instruments has three task groups covering specifications for vacuum-tube voltmeters, signal sources, and cathode-ray instruments.

Other Activities. The Committee on Instruments and Measurements has some 17 representatives on other committees; reports from those representatives at the Summer, Fall, and Winter General Meetings keep the committee members advised as to progress in those fields. The latest representative to be appointed is to the Committee on Electric Welding; this committee has requested assistance on the formulation of measurement procedures.

COMMITTEE ON MAGNETIC AMPLIFIERS

The Committee on Magnetic Amplifiers was organized as a subcommittee of the Committee on Electronics in the fall of 1948, and became a full committee of the Institute in January of 1951. The early work done on definitions and standards and published in the progress report of the Magnetic Amplifier Subcommittee as AIEE paper 51-71 (AIEE *Transactions*, volume 70, part 1, 1951, pages 445–9) has proved very effective in establishing a common ground for discussion of these devices. Much of the early uncertainty about terms, the assorted presentations of data, and the misunderstandings in regard to basic concepts have disappeared.

A wealth of technical and conference papers have appeared, and these are listed together with the entire art in "A Bibliography of Magnetic Amplifiers and the Saturable Reactor Art" (AIEE *Transactions*, volume 70, part II, 1951, pages 2104–23). The subcommittee, later the committee, has sponsored several technical sessions each year, one to three at each of the Winter and Summer General Meetings, and several sessions at other meetings. It sponsored a session on applications at the 1951 National Electronics Conference.

The committee now functions through eight subcommittees, the activities of which are briefly recounted herein.

Subcommittee on Definitions is endeavoring to define such difficult terms as gain, time constant, and drift. The broad field of these devices, the innumerable types of

applications and design variations, coupled with the nonlinear characteristics of the device itself, make it very difficult to provide uniformly significant definitions for these terms, which can tie in with reasonable tests and provide a fundamental basis for standardization. This is a valuable contribution to the art and good progress is being made.

Further standardization work hinges on adequate definitions of time constant, drift, figure of merit, and so forth. Taking "drift" as a specific example, the drift of importance in various applications may be over a long period of time, or a short time, and may be due to aging, or to temperature changes. Hence the significance of these factors must be considered in adopting a definition.

Test Code Subcommittee expects to present an interesting program at the Summer General Meeting. In discussing acceptance tests on cores, it developed that, in addition to fundamental tests, which establish the characteristics of a core received from the manufacturer, a number of the fabricators are using various types of core matching tests and other special magnetic amplifier instrumentation upon which it would be very interesting to exchange notes, and, if possible, to provide demonstrations at the meeting. This plan is materializing for the Summer General Meeting.

Materials Subcommittee has been especially active, both in establishing standardized core dimensions, frequencies, and magnetizations for core testing in the committee, and also in the sponsoring of technical conference sessions. The series of eight papers, four of which were joint with the Committee on Basic Sciences at the Winter General Meeting, covered all phases of the application of oriented nickel-iron alloys and ferrites. The discussion covered the phenomena peculiar to these materials such as the differences between dynamic and d-c hysteresis loops. Particular attention was devoted to the high-frequency characteristics with ultrathin alloys and ferrites going up into the megacycle range, where the devices are being applied to computers and memory storage devices. A similar treatment of rectifiers is planned next.

Application Subcommittee has the function of encouraging submission of application papers, and providing sessions where they may be brought together. It is also its purpose to encourage submission of application papers on magnetic amplifiers in the other committees of the Institute, so that the advances in this new field may be brought to the attention of all interested.

Nonlinear Circuit Subcommittee is functioning at present through limited committee meetings in which a mutual understanding of the current theoretical methods and their assumptions can be obtained.

Dielectric Amplifiers Subcommittee, due to the interest of a large part of the membership and the close similarity between magnetic and dielectric amplifier technology, has been placed under the Committee on Magnetic Amplifiers. A paper covering steady-state characteristics was offered for the Binghamton meeting.

COMMITTEE ON METALLIC RECTIFIERS

The Committee on Metallic Rectifiers held meetings in Toronto, Ontario, Canada, June 1952, and in New York, N. Y., January 1952. Following each meeting, the committee sponsored sessions, each including six papers on metallic rectifiers and rectifier equipment. There were about 100 in attendance in Toronto and 200 in New York.

Definitions Subcommittee reviewed the comments and recommendations from National Electrical Manufacturers Association.

Patents Subcommittee completely rearranged the list of patents and brought them up to date.

Bibliography Subcommittee reported that a new addition was in preparation.

Test Code Subcommittee began preparation of a test code for obtaining the electrical characteristics of metallic rectifiers.

Technical Subcommittee prepared a report on capacitor loading of metallic rectifiers.

COMMITTEE ON NUCLEONICS

Although there continues to be intense activity in fundamental investigations in the field of nucleonics, most of this falls outside the interest of electrical engineers, and it is quite adequately reported in the publications of the American Institute of Physics, and related organizations, except the considerable part which remains cloaked in secrecy. Most of the work under the extensive programs of the Atomic Energy Commission which is of an engineering character falls within the fields of mechanical and chemical engineering. Here, secrecy considerations severely limit the amount of material available for discussion or publication.

In the fields touching on the electrical engineering, instruments and measuring techniques needed in nucleonic investigations, almost without exception, use electronic devices, and are quite closely akin to those used in other broad fields. Therefore, it has seemed more appropriate that instruments of interest to electrical engineers, and open for discussion in forums of AIEE, should be handled by the Committee on Nucleonics, or by the Committee on Instruments and Measurements through the existing joint committees.

During the past year, the Committee on Nucleonics was made rather painfully aware of the severe restrictions that result from secrecy regulations. In three cases, papers tentatively scheduled for presentation were written with great care in an effort to avoid the disclosure of information classified as secret, but in each case formal clearance by the agencies of the Atomic Energy Commission was either not forthcoming, or was so long delayed that it could not meet the Institute schedules, even under the most liberal interpretation.

Lest it be thought that this analysis of the situation overlooks the potential development of electric power using nuclear fuels, it is pointed out that few of the many technical problems that must first be solved come within the field of electrical engineering; they are predominantly problems of mechanical and chemical engineering, including many in the field of metallurgy.

It is believed, therefore, that the Committee on Nucleonics should be kept rather small on an essentially "stand-by" basis until circumstances justify more extensive activity.

AWARDS

EDISON MEDAL

The Edison Medal for 1951 was awarded to Doctor Charles F. Wagner, Consulting Engineer, Westinghouse Electric Corporation, "for his distinguished contributions in the field of power system engineering," and was presented to him on January 21, 1952, during the Winter General Meeting.

The medal may be awarded annually for meritorious achievement in electrical science, electrical engineering, or the electrical arts. Awards are made by a committee of 24 members of the Institute.

LAMME MEDAL

The Lamme Medal for 1951 was awarded to Arthur E. Silver (retired), Ebasco Services, Inc., "for his pioneering of rural electrification by designing the simplified farm-type transformer combined with high voltage, long span, and common neutral line construction." The medal will be presented to him on June 23, 1952, during the Summer General Meeting.

The medal may be awarded annually by a committee of nine members to a member of the AIEE for "meritorious achievement in the development of electrical apparatus or machinery."

JOHN FRITZ MEDAL

The John Fritz Medal may be awarded annually for notable scientific or industrial achievements by a board of award composed of representatives of the American Society of Civil Engineers (ASCE), The American Society of Mechanical Engineers (ASME), American Institute of Mining and Metallurgical Engineers (AIME), and AIEE. The 1952 medal was awarded to Erwin George Bailey, Vice-President, Babcock and Wilcox Company, "for outstanding engineering achievements in the field of combustion and distinguished service to his fellows in advancing the engineering profession."

The medal was presented to him on November 28, 1951, at the annual meeting of ASME.

HOOVER MEDAL

The Hoover Medal for 1951 was awarded to William L. Batt, head of Economic Cooperation Administration for Great Britain, and was presented to him on November 28, 1951, at the annual meeting of ASME.

The Hoover Medal is awarded by a board representing the ASCE, AIME, ASME, and AIEE "for outstanding civic or humanitarian activities constituting distinguished public service."

MARSTON MEDAL BOARD OF AWARD

This medal is presented annually at the commencement exercises of Iowa State College to a graduate of that institution who has achieved success in his field of engineering activity.

The medal was awarded in the year 1951 to a member of the AIEE: Ralph Waldo Atkinson, Chief Research Engineer of the General Cable Corporation, Bayonne, N. J.

WASHINGTON AWARD

The Washington Award for 1952 was made to Doctor Henry Townley Heald, Chancellor

of New York University, "for distinguished leadership in engineering education, industrial technology, scientific research, and civic affairs." It was presented at a joint dinner in Chicago, Ill., on April 21, 1952.

The award is made annually to an outstanding engineer, a citizen or resident of the United States, who ably has served human needs. It is administered by a commission representing the Western Society of Engineers, ASCE, AIME, ASME, and AIEE.

ALESSANDRO VOLTA MEMORIAL FUND

The Board of Trustees of the Alessandro Volta Memorial Fund made the first award of the fund under Institute auspices to Giovanni Malaman of Milan, Italy. Mr. Malaman is a graduate of the University of Padua and an employee of the Edison Company of Milan. Under the grant from the Volta Fund, he has been spending the past academic year at Yale University taking graduate work relating to the stability of electric power systems and machinery.

During the Winter General Meeting, a small luncheon in honor of Mr. Malaman was given by the Institute, attended by President McMillan, members of the Board of Trustees of the Volta Fund, and others.

Subject to the necessary arrangements being worked out, the Board of Trustees has voted to award the second Volta Fellowship, for the academic year 1952–53, to Enrico Chiesa of Milan. Mr. Chiesa is a graduate of the University of Milan, and is employed by the General Electric Company of Milan. For his year of study, he proposes to specialize in electronics and servomechanisms.

CHARLES LeGEYT FORTESCUE FELLOWSHIP COMMITTEE

The availability of this award was brought to the attention of the department heads of electrical engineering in the country that offer accredited programs. Financial statements were reviewed by the committee members, and it was decided to award two fellowships for the academic year of 1952–53, each fellowship carrying a stipend of $1,200. A total of 22 applications were received. All applicants appeared to be highly qualified.

The recipients of the award for the coming year are Amar G. Bose, a graduate student of the department of electrical engineering at Massachusetts Institute of Technology, and James E. Shea, a graduate of the University of Connecticut department of electrical engineering.

ALFRED NOBLE PRIZE

The Alfred Noble Prize for 1951 was awarded to Eldo C. Koenig, Associate Member AIEE, for his paper "An Electric Analogue Computer Using the Photocell as a Nonlinear Element."

Fourteen AIEE papers were eligible for the prize and from these Mr. Koenig's paper was selected and presented to the committee. Eligible papers must have been written by members who have not reached their 31st birthday at the time when their papers were submitted for publication. Each of four other societies also select a best paper. These societies are ASCE, ASME, AIME, and the Western Society of Engineers (WSE). Each society is permitted to make one entry. A handsome certificate and substantial cash award is made to the winner.

The prize was created in 1929 to perpetuate the achievements and ideals of Alfred Noble, Past President of ASCE and WSE. It has been awarded 18 times, including 9 times to AIEE members.

JOINT ACTIVITIES

UNITED ENGINEERING TRUSTEES, INC.

For the four Founder Societies, the United Engineering Trustees, Inc., administers the funds and property in the Engineering Societies Building, the Engineering Societies Library, and the Engineering Foundation. It also serves as Treasurer of the Engineers' Council for Professional Development.

While continuing to seek possibilities for obtaining a new building, the Board of Trustees has endeavored to keep the cost of repairs and renewals to a minimum.

ENGINEERING FOUNDATION

The Engineering Foundation is a department of the United Engineering Trustees, Inc., and its general objective is "the furtherance of research in science and engineering."

The AIEE representatives on the Engineering Foundation Board report that the Foundation made the usual research grants within its budget, totaling $35,800; that consideration was given at several meetings of the Board to methods of stimulating engineering research projects, and to methods of financing additional work in areas of proper interest to the engineering profession as a whole. Members of the AIEE may obtain copies of the Annual Report of the Engineering Foundation for 1951 by addressing a request to the Director at 33 West 39th Street, New York 18, N. Y.

ENGINEERING SOCIETIES LIBRARY

The library is a department of the United Engineering Trustees, Inc., and was formed by combining the separate libraries of the ASCE, AIME, ASME, and AIEE, and is conducted as a free public reference library.

In addition to affording the use of a large collection of engineering books and periodicals, the library renders special services such as bibliographies, translations, photostats, searches, and book loans by mail.

Observations

1. While the library could use more money to raise salaries and otherwise provide for more efficient service, there is a general opinion in the Library Board that income will follow if the services are more generally understood and used by the profession within and outside the Founder Societies. There has been a growing use of such services as photostats, microfilms, searches, and translations. The income from these sources have increased threefold in the last 20 years. In the same period, income from the Founder Societies has increased about 50 per cent. This has been entirely the result of the rise in membership, because the library contribution per member has remained fixed for that period.

2. The Board has discussed and devised various means of carrying the story of the library to the membership of the Founder Societies and others around the country. The director is traveling more to conventions and other occasions where he can effectively represent the library. Progress has been made toward the preparation of a set of slides and a "canned" lecture to be offered to Section meetings as a short feature to be included on the programs. Displays are being prepared for conventions.

3. The purpose of this promotional work is to encourage more use of the library and its facilities as a research tool by individuals and corporations, and perhaps to attract expressions of appreciation in the form of tax-free contributions to augment the income of the library.

4. Certain technical societies outside the Founder group contributed a total of over $2,000 during the past year.

5. The library makes about 35,000 service contacts in a year's time, about half of these representing visitors to the library. The trend is for the nonvisitor contacts to increase. Whether this is an indication of wider use or merely less leisure time to visit the library is not clear.

6. A distressing amount of vandalism was reported during the past several years. The Board authorized an expenditure of about $500 for a rearrangement of facilities to combat the evil. The results of this move are not yet known.

Conclusions

1. The library is ably directed, and is meeting the current demands of the profession as efficiently as its funds and facilities permit.

2. The most serious limitation is imposed by the inability to staff the library with high-grade personnel. The salaries available cannot attract good people and hold them. There is a general shortage of librarians.

3. The lack of adequate personnel delays the critical selection and evaluation of material that is essential in trimming down the stacks and keeping the collection in good working condition.

4. The library is not used by the membership of the Founder Societies to nearly the extent that it should be. Its services should be better known and appreciated throughout the country. Its use should be more extensive and intensive. Members outside New York should be using the services to a much greater extent than they are.

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

The principal activities of ECPD include programs for the guidance of young persons thinking of entering the engineering field, the accrediting of curricula of engineering schools, and encouragement and assistance to individuals in their engineering and cultural studies during several years following graduation. The council represents ASCE, AIME, ASME, AIEE, The American Institute of Chemical Engineers (AIChE), the Engineering Institute of Canada, the American Society for Engineering Education, and the National Council of State Boards of Engineering Examiners.

The current administrative year of ECPD has shown an encouraging amount of unity of purpose and action on the part of its member bodies. AIEE participation is at

least comparable with that of any member group, four of the seven standing committees having AIEE members as chairmen. Extensive work on a national basis is being pursued in the matter of guidance for secondary school students seeking entrance to engineering colleges, this work being of particular importance in view of the impending shortage of engineering graduates. For continued training of young engineers who have just entered industry, a pilot project is about to be initiated at a location as yet undetermined. The large regional committees established for accreditation of undergraduate engineering curricula are being expanded. Studies under way concern the adequacy and standards of present-day engineering education. The continuing work of the Council is carried on under the general approval of its sponsoring bodies.

ENGINEERS JOINT COUNCIL

The principal functions of EJC are to study matters of mutual interest to the five member societies, ASCE, AIME, ASME, AIEE, and AIChE, recommend joint action when desirable, and administer activities as authorized by the societies. The membership includes the two most recent available past presidents and the secretaries; also, the presidents as ex officio members without votes.

The Engineering Manpower Commission of EJC has continued its extensive efforts to aid in the establishment of policies for the most effective utilization of engineers both in the Armed Forces and in civilian employment, and has distributed to all high schools in the country material intended to cause many more students to enter the engineering schools.

The Exploratory Group to Consider Further Unity in the Engineering Profession, composed of representatives of 15 engineering societies, submitted a report in December 1951, which is now before all of the societies for action. The report is based upon a recommended expansion of EJC under Plan *A*.

EJC was represented at the second meeting of UPADI (Union of Pan American Engineering Societies) in Havana, Cuba, April 19–23, 1951. Preparations are being made for the third meeting in New Orleans, La., August 25–30, 1952.

At the request of the United States Salary Stabilization Board, EJC organized a panel, in August 1951, to prepare a statement of principles based upon the effects of anti-inflationary regulations on engineering salary structures. Recommendations were submitted in September 1951.

Many other matters were also considered during the year by the EJC and its committees.

JOINT AIEE-IRE CO-ORDINATION COMMITTEE

This committee has now been functioning for about 2 years. It consists of two representatives of each Board of Directors. Its function is to discuss questions of mutual interest and to recommend appropriate action and procedures in connection therewith.

During the last 12 months, one meeting was held, at which such topics as the operation of joint Student Branches, the evaluation of foreign schools where students apply for Student membership, and the conduct of joint conferences were considered.

It seems likely that better co-ordination could be obtained if the committee met at least twice each year.

REPRESENTATIVES

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The AIEE representatives on the Council of the AAAS report that no joint activities between the Institute and the AAAS were conducted during the past year, nor has any matter arisen in the Council of particular interest to the AIEE.

GENERAL ELECTRIC EDUCATIONAL FUND FELLOWSHIP COMMITTEE

Applicants and Awards for 1950–51, 1951–52, 1952–53

	1950–51		1951–52		1952–53	
Field	Applicants	Awards	Applicants	Awards	Applicants	Awards
Chemistry	29	3	22	2	22	2*
Physics	26	7	17	3	39	3*
Industrial Management	12		3		11	
Metallurgy	1		1		7	1*
Mathematics	1		1		1	
Astrophysics					2	
Statistics					1	
Engineering						
Electrical	20	6	13		24	3*
Mechanical	7		6	3	8	2*
Chemical	2	1	9	2	8	1*
Civil	1	1	1	1	1	
Geological		1	1			
Aeronautical					1	

* Subject to change, depending upon acceptance by award winners.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS

The fourth annual meeting of the Inter-Society Corrosion Committee was held in Galveston, Tex., on March 13, 1952, in connection with the eighth annual conference of the National Association of Corrosion Engineers. Written reports in varying degrees of detail were received from 18 of the 30 technical societies and government agencies represented on the committee, covering current and projected work in corrosion research and prevention. These reports, and other reports and discussions at the meetings of the committee, are of much value in co-ordinating activity in the wide and varied field of corrosion. Further helpful steps in this direction have been taken in the work of subcommittees on a Directory of Corrosion Research Activities and Workers and on Definitions and Terminology.

The sponsor organization of the committee is the National Association of Corrosion Engineers, which participates on an equal footing with other represented societies in the work of the committee. This association has an organization of 19 technical practices committees, which deal with many sectors of the general field of corrosion. Of special interest to AIEE members probably will be two of these committees working on different aspects of cathodic protection, and a third, recently formed, on corrosion by de-icing salts.

NATIONAL ELECTRONICS CONFERENCE

The seventh annual National Electronics Conference was held in Chicago, Ill., October 22–24, 1951, with a record attendance of 4,100. Three general and 76 technical papers were presented. Other parts of the conference were a large exhibit of electronic components and equipment, and a program of events for the ladies.

NATIONAL FIRE WASTE COUNCIL

The two AIEE representatives attended the thirtieth annual meeting of the National Fire Waste Council, which was held in Washington, D. C., on April 4, 1952. The theme of the meeting was "Toward Better Community Fire Protection." The speakers emphasized the importance of team work of groups, including engineers, boy scouts, and others, in fire prevention. During 1952, the Council is making a special drive to make student housing fire safe.

The AIEE Student Branches might well give consideration to fire prevention, as electrical failures are reported as being the cause of about one-fifth of all fires in this country.

NATIONAL RESEARCH COUNCIL

The National Research Council of the National Academy of Sciences has been active in many fields during the year. Of particular interest to engineers are its Highways Research Board, its Building Research Advisory Board, its Conference on Electrical Insulation, and its Committees on Residual Stresses and Ship Steel.

The Council has given much attention to the problem of relieving the deficit of trained scientific personnel and of finding qualified men to aid the military establishment. It has also co-operated with the Department of State in the international exchange of persons and the Fulbright program.

THE THOMAS ALVA EDISON FOUNDATION

The Thomas Alva Edison Foundation, Inc., was established in 1946, having as its purpose "Exclusively for such charitable scientific, literary or educational purposes within the United States or its possessions as in the judgment of the directors or trustees of the corporation shall be in furtherance of the public welfare and tend to promote the well-being of the people of the United States . . . . . to develop means and methods to reduce to practical use the results of such investigation, research, and discovery . . . . . to provide for the teaching and dissemination of knowledge and publication of data of all kinds . . . . . to establish or maintain in whole or in part, charitable, scientific, literary or educational activities, agencies, institutes, or corporations or aid any such activities. . . . . "

The activities of the Foundation include the operation and maintenance of the laboratory of Thomas Alva Edison as a museum open to the public.

Until December 31, 1947, no grants or loans had been made and no reports published.*

In a letter from the Foundation to the AIEE January 8, 1948, it was requested that five representatives of the Institute be ap-

* See 1948 issue of "American Foundations and Their Fields—VI," Raymond Rich Associates, New York, N. Y.

pointed to an Engineering Societies Committee.

The immediate objective of this committee was to secure the wholehearted cooperation of the engineering societies devoted to those branches of engineering in which Mr. Edison's inventions play an important part.

In accordance with the Foundation's request, the following five representatives were appointed: T. F. Barton, R. K. Honaman, M. D. Hooven, A. E. Knowlton, and R. T. Henry. Since Mr. Henry's retirement, G. J. Lowell has been appointed to replace Mr. Henry.

Among recent activities of the Foundation, may be mentioned particularly the sponsorship of educational seminars. These have brought together people from industry and from education for the purpose of discussing problems related to the education of engineers. Educators at the secondary school level and particularly those concerned with the guidance of high school graduates have participated in these seminars.

The Foundation also conducts a series of public lectures each year, most of which are given in Newark, N. J.

None of these activities have directly involved the engineering societies and there have been no meetings of the Engineering Societies Committee since the appointments were made, but representatives of the AIEE on the Foundation have from time to time, as individuals, been consulted by the Executive Director of the Foundation.

APPRECIATION

In common with the annual reports for recent fiscal years, this report for 1951–52 presents records of continuing rapid growth in membership and significant expansion of technical activities. For the splendid activities and developments of the year, the Board of Directors expresses its appreciation and thanks to the general and technical committees, to the District, Section, and Branch officers and committees, and to the membership in general.

Respectfully submitted for the Board of Directors.

H. H. HENLINE
Secretary

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit A — **Balance Sheet, April 30, 1952**

ASSETS

Property Fund Assets:		
One-fourth interest in physical properties of United Engineering Trustees, Inc.:		
Land, buildings, and equipment (less depreciation and renewal reserve)	$293,021.26	
Funded depreciation and renewal reserve	205,427.22	
Total	$498,448.48	
Equipment:		
Library (nominal value)	1.00	
Office furniture and fixtures (less reserve for depreciation, $38,562.77)	27,944.62	
Works of art, etc.	3,001.35	
Total property fund assets		$ 529,395.45
Restricted Fund Assets:		
Securities—at cost (quoted market value, $699,466.25)—Schedule 1	$624,714.94	
Cash (including $7,092.28 Canadian funds):		
Reserve capital fund	736.26	
Life membership fund	1,668.37	
Member-for-Life fund	4,824.21	
International Electrical Congress of St. Louis Library fund	1,575.54	
Lamme Medal fund	205.93	
Mailloux fund	1,024.50	
Volta Memorial fund	922.30	
Retired employees insurance fund	2,000.00	
Accrued interest receivable	251.85	
Total restricted fund assets		637,923.90
Operating Fund Assets:		
Cash (not including $2,718.13 for Federal taxes withheld from employees)	$ 42,402.30	
Accounts receivable:		
Members—for dues (less reserve, $13,500.00)	11,483.41	
Advertisers	3,362.37	
Technical Conference loans	750.00	
Miscellaneous (less reserve, $1,500.00)	6,115.53	
Accrued interest receivable	2,201.77	
Inventories:		
Transactions, etc.	3,121.00	
Text and cover paper	17,125.79	
Badges	7,676.77	
Deferred charges:		
Production charges for May issue of *Electrical Engineering*	21,325.92	
Travel advances	1,150.00	
Total operating fund assets		116,714.86
Total		$1,284,034.21

LIABILITIES

Property Fund Reserve		$ 529,395.45
Restricted Fund Reserves (Exhibit C):		
Reserve capital fund	$584,167.97	
Life membership fund	6,711.07	
Member-for-Life fund	14,685.66	
International Electrical Congress of St. Louis Library fund	6,618.24	
Lamme Medal fund	4,167.91	
Mailloux fund	1,024.50	
Volta Memorial fund	18,548.55	
Retired employees insurance fund	2,000.00	
Total restricted fund reserves		637,923.90
Operating Fund Reserve, Liabilities, Etc.:		
Accounts payable	$ 30,758.17	
Deferred income:		
Dues received in advance	4,440.33	
Entrance fees and dues advanced by applicants for membership	1,632.45	
Subscriptions to publications received in advance	24,528.29	
Miscellaneous (including unallocated receipts)	1,701.22	
Operating fund reserve (Exhibit B)	53,654.40	
Total operating fund reserve, liabilities, etc.		116,714.86
Total		$1,284,034.21

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit B — **Statement of Income and Operating Fund Reserve for the Year Ended April 30, 1952**

Income:		
Dues (including $230.586.00 allocated to *Electrical Engineering* subscriptions)	$491,821.37	
Advertising in *Electrical Engineering*	255,952.00	
Transactions subscriptions	15,464.20	
Electrical Engineering subscriptions	33,680.88	
Miscellaneous publications (preprints, Standards, and other publication)	62,931.17	
Students' fees	35,797.50	
Entrance fees	22,417.30	
Registration fees—Institute meetings and technical conferences	26,707.19	
Membership badges	4,726.09	
Transfer fees	4,020.00	
Interest and dividends on investments of Reserve Capital Fund	27,644.55	
Refund of prior year contribution to Engineering Manpower Commission of Engineers Joint Council	2,082.50	
Total income		$983,244.75
Expenses:		
Publications expense:		
Electrical Engineering text	$198,764.61	
Electrical Engineering advertising	122,456.75	$321,221.36
Transactions	29,240.62	
Proceedings	44,065.73	
"Year Book"	22,984.42	
Bimonthly publications (including technical division questionnaire, $2,693.81)	3,269.22	
Miscellaneous publications (preprints, Standards, and other publications)	47,259.46	
Institute meetings	33,303.50	
Institute Sections	96,614.74	
Institute Branches, including paper prizes, etc.	11,828.64	
Finance Committee	850.00	
Headquarters Committee	333.20	
Membership Committee	23,893.90	
Forward	$634,864.79	$983,244.75
Total Income (forward)		$983,244.75
Expenses (forward)	$634,864.79	
Standards Committee	18,826.01	
Technical committees	16,854.07	
Committee on Public Relations	8,976.87	
Constitution and Bylaws Committee	2,588.16	
Edison Medal Committee	390.15	
Lamme Medal Committee	101.45	
Traveling expenses:		
Geographical Districts:		
Executive committees	9,739.03	
Vice-Presidents	2,041.79	
Conferences on student activities	19,803.76	
Board of Directors	13,071.57	
Nominating Committee	1,468.96	
President's appropriation	756.27	
Institute representatives	160.00	
Centennial of Engineering	1,000.00	
Administrative expenses	117,322.15	
Geographical Districts—Branch paper prizes	761.96	
Institute prizes	595.86	
Retirement system AIEE—normal contribution	9,610.30	
American Standards Association	1,500.00	
Conference of Engineering Societies of Western Europe	906.27	
Engineers' Council for Professional Development	5,160.70	
Engineering Foundation Project—Welding Research	250.00	
Engineers Joint Council	1,612.28	
National Council of State Boards of Engineering Examiners	500.00	
United States National Committee—International Commission on Illumination	300.00	
National Fire Protection Association	100.00	
United Engineering Trustees, Inc.:		
Building assessments	22,373.99	
Library assessments	16,697.55	
Library retirement plan	3,899.20	
Membership badges	6,924.74	
Legal services	250.00	
Rent, etc.—Editorial office, 500 Fifth Avenue	6,908.91	
Exchange allowances	8,920.16	
Provision for doubtful accounts	7,300.00	
Transfer to Property Fund Reserve for furniture and fixtures expenses	4,284.91	
Total expenses		946,821.86
Excess of Income over Expenses for the Year		$ 36,422.89
Operating Fund Reserve, May 1, 1951		17,231.51
Operating Fund Reserve, April 30, 1952		$ 53,654.40

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit C — **Statement of Restricted Fund Reserves for the Year Ended April 30, 1952**

	Total	Reserve Capital Fund	Life Membership Fund	Member-for-Life Fund	International Electrical Congress of St. Louis Library Fund	Lamme Medal Fund	Mailloux Fund	Volta Memorial Fund	Retired Employees Insurance Fund
Balance, May 1, 1951	$602,355.33	$548,767.87	$7,357.51	$12,719.21	$6,608.69	$4,440.44	$1,023.44	$19,438.17	$2,000.00
Additions:									
Income from bonds	$ 1,098.07		$ 137.50	$ 262.50	$ 137.50	$ 157.34	$ 20.56	$ 382.67	
Interest on bank balances	38.07		38.07						
Allocated portion of dues	2,616.00			2,616.00					
Profit (loss) on sale of securities, etc.	35,063.57	35,400.10				(254.87)		(81.66)	
Total additions	$ 38,815.71	$ 35,400.10	$ 175.57	$ 2,878.50	$ 137.50	$ (97.53)	$ 20.56	$ 301.01	
Total	$641,171.04	$584,167.97	$7,533.08	$15,597.71	$6,746.19	$4,342.91	$1,044.00	$19,739.18	$2,000.00
Deductions:									
Authorized withdrawal from Life Membership Fund	$ 822.01		$ 822.01						
Purchase of medal, cost of engraving, etc. (exclusive of $101.45 paid from operating fund)	175.00					$ 175.00			
Library purchases	147.45				$ 127.95		$ 19.50		
Traveling expenses—District Branch prize winners	912.05			$ 912.05					
Scholarship award	1,190.63							$ 1,190.63	
Total deductions	$ 3,247.14		$ 822.01	$ 912.05	$ 127.95	$ 175.00	$ 19.50	$ 1,190.63	
Balance, April 30, 1952 (Exhibit A)	$637,923.90	$584,167.97	$6,711.07	$14,685.66	$6,618.24	$4,167.91	$1,024.50	$18,548.55	$2,000.00

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Schedule 1 — **Securities Owned, April 30, 1952**

	Principal Amount of Bonds or Number of Shares of Stock	Restricted Funds						
		Reserve Capital Fund	Life Membership Fund	Member-for-Life Fund	International Electrical Congress of St. Louis Library Fund	Lamme Medal Fund	Volta Memorial Fund	Total
Railroad Bonds:								
Baltimore & Ohio, Pittsburgh, Lake Erie & West Virginia System refunding 4%, due 1980	$10,000.00	$ 6,450.00						$ 6,450.00
New York Central Railroad Company 4% series A consolidated mortgage, due 1998	15,000.00	9,812.50						9,812.50
Northern Pacific Railway Company 4½% collateral trust, due 1975	14,000.00	14,287.10						14,287.10
Total railroad bonds		$ 30,549.60						$ 30,549.60
Public Utility Bonds:								
American Telephone & Telegraph Company 2¼% debentures, due 1971	$ 5,000.00			$4,775.00				$ 4,775.00
American Telephone & Telegraph Company 2¼% debentures, due 1975	20,000.00	$ 10,062.50	$5,031.25		$5,031.25			20,125.00
Philadelphia Electric Company first refunding 2¾%, due 1967	10,000.00	10,325.00						10,325.00
Total public utility bonds		$ 20,387.50	$5,031.25	$4,775.00	$5,031.25			$ 35,225.00
Industrial Bonds:								
Shell Union Oil Company 2½% debentures, due 1971	$20,000.00	$ 19,800.00						$ 19,800.00
Standard Oil Company of New Jersey 2¼% debentures, due 1971	20,000.00	19,675.00						19,675.00
Total industrial bonds		$ 39,475.00						$ 39,475.00
Dominion of Canada, Externals 3%, Due 1963	$ 1,000.00						$ 1,003.75	$ 1,003.75
United States Government Bonds:								
Defense bonds series G 2½%, due December 1, 1954	18,000.00	$ 13,000.00		$5,000.00				$ 18,000.00
Treasury savings bonds series G 2½%, due September 1, 1955	40,000.00	40,000.00						40,000.00
Treasury savings bonds series G 2½%, due November 1, 1956	17,000.00	17,000.00						17,000.00
Treasury savings bonds series G 2½%, due May 1, 1957	20,000.00	20,000.00						20,000.00
Treasury savings bonds series G 2½%, due October 1, 1957	30,000.00	30,000.00						30,000.00
Treasury savings bonds series G 2½%, due May 1, 1961	30,000.00	30,000.00						30,000.00
Treasury savings bonds series G 2½%, due July 1, 1961	15,000.00	15,000.00						15,000.00
Treasury bonds 2½%, due December 15, 1962/59	16,000.00						$16,480.00	16,480.00
Total United States Government bonds		$165,000.00		$5,000.00			$16,480.00	$186,480.00
Total bonds		$255,412.10	$5,031.25	$9,775.00	$5,031.25		$17,483.75	$292,733.35
Capital Stocks:								
Preferred Stocks:								
Atchison, Topeka & Santa Fe Railway Company	400 shares	$ 19,174.71						$ 19,174.71
Dow Chemical $4 cumulative, series A	100 shares	11,547.50						11,547.50
E. I. du Pont de Nemours & Company $4.50 cumulative	33 shares					$3,961.98		3,961.98
General Motors Corporation $5	200 shares	25,820.00						25,820.00
Ohio Edison Company 4.40%	200 shares	21,279.25						21,279.25
Scoville Manufacturing Company 3.65% cumulative	100 shares	10,111.25						10,111.25
United States Steel Corporation 7% cumulative	100 shares	14,885.00						14,885.00
Total preferred stocks		$102,817.71				$3,961.98		$106,779.69
Common Stocks:								
American Gas & Electric Company	420 shares	$ 15,069.04						$ 15,069.04
Caterpillar Tractor Company	300 shares	14,367.28						14,367.28
Consolidated Natural Gas Company	100 shares	4,428.80						4,428.80
Eastman Kodak Company	363 shares	9,699.90						9,699.90
E. I. du Pont de Nemours & Company	300 shares	12,278.14						12,278.14
General Electric Company	200 shares	7,748.66						7,748.66
General Motors Corporation	200 shares	4,235.53						4,235.53
Gulf Oil Corporation	300 shares	9,198.20						9,198.20
Halliburton Oil Well Cementing Company	200 shares	9,624.07						9,624.07
International Paper Company	300 shares	14,479.88						14,479.88
Louisville & Nashville Railroad Company	100 shares	6,278.13						6,278.13
Montgomery Ward Company	300 shares	22,237.65						22,237.65
Owens-Illinois Glass Company	100 shares	7,758.73						7,758.73
Pacific Gas and Electric Company	200 shares	8,316.23						8,316.23
Public Service Company of Indiana	300 shares	8,547.39						8,547.39
Public Service Electric and Gas Company $1.40 dividend preference common stock	500 shares	14,462.43						14,462.43
Sears, Roebuck and Company	400 shares	6,014.97						6,014.97
Socony Vacuum Oil Company	400 shares	8,216.87						8,216.87
Standard Oil Company of New Jersey	400 shares	9,910.35						9,910.35
Standard Oil Company of Ohio	330 shares	15,272.04						15,272.04
Texas Utilities Corporation	300 shares	9,780.19						9,780.19
Union Carbide & Carbon Corporation	300 shares	7,277.42						7,277.42
Total common stocks		$225,201.90						$225,201.90
Total capital stocks		$328,019.61				$3,961.98		$331,981.59
Total		$583,431.71	$5,031.25	$9,775.00	$5,031.25	$3,961.98	$17,483.75	$624,714.94

HASKINS & SELLS
CERTIFIED PUBLIC ACCOUNTANTS

250 PARK AVENUE
NEW YORK 17

ACCOUNTANTS' CERTIFICATE

American Institute of Electrical Engineers:

We have examined the balance sheet of American Institute of Electrical Engineers, and schedule of securities owned, as of April 30, 1952, and the related statements of income and operating fund reserve and of restricted fund reserves for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet, schedule of securities owned, and statements of income and operating fund reserve and of restricted fund reserves present fairly the financial position of, and securities owned by, the Institute at April 30, 1952 and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(*Signed*) HASKINS & SELLS

New York,
May 23, 1952

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(*Term expires July 31, 1953*)

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(Terms expire July 31, 1953)
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(Terms expire July 31, 1955)

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(Terms expire July 31, 1955)
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(Terms expire July 31, 1956)
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(Terms expire July 31, 1957)

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(Terms expire July 31, 1954)

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(Terms expire July 31, 1954)
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Dr. C. K. Drinker, P. O. Box 502, Falmouth, Mass.
Dr. Archer Gordon, University of Illinois, Medical Center, Chicago, Ill.
Dr. B. L. Vosburgh, General Electric Company, 1 River Road, Schenectady 5, N. Y.

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R. F. Snyder — Akron, Ohio
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H. C. Uhl — Sylacauga, Ala.
L. A. Umansky — Schenectady, N. Y.
W. D. Vincent — Seattle, Wash.
B. H. Zacherle — Philadelphia, Pa.

Committee on Industrial Control

J. A. Cortelli, *Chairman;* Clark Controller Company, 1146 East 152d Street, Cleveland 10, Ohio

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L. H. Matthias, *Secretary* — Milwaukee, Wis.
E. H. Alexander — Schenectady, N. Y.
H. H. Angel — Bethlehem, Pa.
T. H. Bloodworth — Milwaukee, Wis.
J. R. Dickey — Corpus Christi, Tex.
E. F. Drake — Port Townsend, Wash.
W. H. Elliot — Milwaukee, Wis.
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H. G. Frostick — Pittsburgh, Pa.

J. E. Gahagan — Binghamton, N. Y.
J. A. Gienger — Rochester, N. Y.
F. Y. Grepe — Toronto, Ontario, Canada
Walter Hansen — Boston, Mass.
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A. M. Hopkin — Evanston, Ill.
E. W. Hutton — Schenectady, N. Y.
J. J. Jaeger — West Hartford, Conn.
R. W. Jones — Evanston, Ill.
R. W. Kowitz — Dearborn, Mich.
W. E. Lawton — Wenatchee, Wash.
E. J. Limpel — Milwaukee, Wis.
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A. L. R. Maynard — Philadelphia, Pa.
C. E. McRoberts — Toronto, Ontario, Canada
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R. W. Moore — Buffalo, N. Y.
J. M. Morgan — Cincinnati, Ohio
E. E. Moyer — Troy, N. Y.
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H. R. Walker — Midland, Mich.

Committee on Industrial Power Systems

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Committee on Mining and Metal Industry

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Power Division

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T. T. Smith — Portland, Oreg.
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Mead Warren, Jr. — Alcoa, Tenn.
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Jean Youngblood — Detroit, Mich.

Committee on Insulated Conductors

C. T. Hatcher, *Chairman;* Consolidated Edison Company of New York, Inc., 4 Irving Place, New York 3, N. Y.
R. J. Wiseman, *Vice-Chairman* — Passaic, N. J.
M. H. McGrath, *Secretary* — Perth Amboy, N. J.
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C. E. Betzer — Chicago, Ill.
Andrew Bodicky — St. Louis, Mo.
A. S. Brookes — Newark, N. J.
W. R. Bullard — New York, N. Y.
H. W. Clark — Washington, D. C.
E. W. Davis — Cambridge, Mass.
W. A. Del Mar — Yonkers, N. Y.
C. D. Eash — Jackson, Mich.
D. M. Farnham — Montreal, Quebec, Canada
G. H. Fiedler — Rochester, N. Y.
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Herman Halperin — Chicago, Ill.
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R. A. Hopkins — Knoxville, Tenn.
B. R. Hubbard — Trenton, N. J.
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L. I. Komives — Detroit, Mich.
M. J. Lowenberg — Boston, Mass.
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Committee on Power Generation

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W. C. Beattie — New York, N. Y.
E. P. Bryant — Los Angeles, Calif.
Giuseppe Calabrese — New York, N. Y.
H. E. Deardorff — Dayton, Ohio
S. M. Denton — Denver, Colo.
E. F. Dinmeyer — Jackson, Mich.
Alex Dovjikov — Portland, Oreg.
R. E. Dyer — Abernathy, Tex.
C. C. Farrell — Philadelphia, Pa.
C. B. Fontaine — Lynn, Mass.
G. P. Gamble — St. Louis, Mo.
R. M. Goar — Kansas City, Mo.
W. P. Hammond — Atlanta, Ga.
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J. A. Hooper — Portland, Oreg.
G. W. Kerr — Walla Walla, Wash.
C. E. Kilbourne — Schenectady, N. Y.
A. J. Krupy — Chicago, Ill.
Walter La Pierre — New York, N. Y.
F. L. Lawton — Montreal, Quebec, Canada
J. T. Madill — Montreal, Quebec, Canada
E. F. Maryatt — San Francisco, Calif.
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M. D. Ross — East Pittsburgh, Pa.
G. E. Schmitt — Austin, Tex.

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B. G. A. Skrotzki — New York, N. Y.
W. E. Taylor — Toronto, Ontario, Canada
C. W. Watchorn — Baltimore, Md.
W. F. Wetmore — Detroit, Mich.
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R. R. Wisner — Boston, Mass.
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Committee on Protective Devices

H. R. Stewart, *Chairman;* New England Power Service Company, 441 Stuart Street, Boston 16, Mass.
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S. E. Caldwell — Portland, Oreg.
D. D. Clarke — Kansas City, Mo.
J. O. Coleman — Boston, Mass.
L. M. Connors — Toronto, Ontario, Canada
H. A. Cornelius — Chicago, Ill.
F. M. Defandorf — Washington, D. C.
G. K. Ditlow — Washington, D. C.
G. B. Dodds — Pittsburgh, Pa.
J. R. Easton — Lafayette, Ind.
T. L. Eldridge — Philadelphia, Pa.
Byron Evans — Denver, Colo.
O. L. Giersch — Charlotte, N. C.
W. D. Hardaway — Denver, Colo.
E. M. Hunter — Schenectady, N. Y.
P. A. Jeanne — New York, N. Y.
K. H. Kidd — Toronto, Ontario, Canada
W. A. Lewis, Jr. — Chicago, Ill.
F. R. Longley — Springfield, Mass.
Curt Lowerison — Los Angeles, Calif.
W. A. McMorris — Pittsfield, Mass.
R. H. Mertz — Detroit, Mich.
R. E. Neidig — Reading, Pa.
Einar Nilsson — San Francisco, Calif.
E. G. Norell — Chicago, Ill.
A. M. Opsahl — East Pittsburgh, Pa.
H. L. Rorden — Portland, Oreg.
O. L. Sidenfaden — Los Angeles, Calif.
H. O. Stoelting — South Milwaukee, Wis.
J. M. Towner — Baltimore, Md.
C. L. Wagner — East Pittsburgh, Pa.
S. B. Watkins — New York, N. Y.

Committee on Relays

A. J. McConnell, *Chairman;* General Electric Company, 1 River Road, Schenectady 5, N. Y.
W. E. Marter, *Vice-Chairman* — Pittsburgh, Pa.
Frank Von Roeschlaub, *Secretary* — New York, N. Y.
A. W. Adams — Portland, Oreg.
J. E. Barkle, Jr. — East Pittsburgh, Pa.
H. G. Barnes — New York, N. Y.
M. A. Bostwick — Portland, Oreg.
J. W. Bowman — Fort Wayne, Ind.
L. L. Brandow — Binghamton, N. Y.
F. P. Brightman — Schenectady, N. Y.
G. E. Brooks — Oklahoma City, Okla.
R. J. Cooper — Atlanta, Ga.
R. E. Cordray — Philadelphia, Pa.
M. A. Faucett — Urbana, Ill.
F. S. Fehr — Reading, Pa.
L. F. Ferri — Jackson, Mich.
L. L. Fountain — East Pittsburgh, Pa.
Sidney Goldsmith — Cincinnati, Ohio
E. T. B. Gross — Chicago, Ill.
T. R. Halman — Detroit, Mich.
G. W. Hampe — Chicago, Ill.
V. J. Hayes — Hartford, Conn.
B. C. Hicks — Montreal, Quebec, Canada
R. O. Hopkins — Beaumont, Tex.
E. F. King — West Orange, N. J.
R. A. Larner — Fort Worth, Tex.
S. C. Leyland — Newark, N. J.
H. F. Lindemuth — New York, N. Y.
J. R. Linders — Cleveland, Ohio
Curt Lowerison — Los Angeles, Calif.
G. W. McKenna — Philadelphia, Pa.
H. R. McKinney — Los Angeles, Calif.
H. A. McLaughlin — Poughkeepsie, N. Y.
M. S. Merritt — Chattanooga, Tenn.
M. P. Osburn — Toronto, Ontario, Canada
C. E. Parks — Plainfield, Ind.
Arthur Scott — San Francisco, Calif.
H. P. Sleeper — Newark, N. J.
W. K. Sonnemann — Newark, N. J.
George Steeb — Buffalo, N. Y.
R. W. World — Denver, Colo.

Committee on Rotating Machinery

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L. W. Buchanan, *Secretary* — Lima, Ohio
P. L. Alger — Schenectady, N. Y.
W. R. Appleman — Dayton, Ohio

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Sterling Beckwith — Milwaukee, Wis.
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C. F. Cameron — Stillwater, Okla.
James DeKiep — Minneapolis, Minn.
L. O. Dorfman — New York, N. Y.
F. A. Eastom — Boulder, Colo.
W. H. Fifer — Washington, D. C.
L. T. Fisher — Portland, Oreg.
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J. L. Fuller — Cleveland, Ohio
R. W. Gaskins — St. Louis, Mo.
Lanier Greer — Cleveland, Ohio
A. M. Harrison — East Pittsburgh, Pa.
C. B. Hathaway — Buffalo, N. Y.
S. F. Henderson — Buffalo, N. Y.
G. L. Hill — Emeryville, Calif.
W. R. Hough — Cleveland, Ohio
J. W. Jones — Philadelphia, Pa.
Richard Lamborn — Erie, Pa.
I. M. Levy — Dayton, Ohio
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R. C. Moore — Milwaukee, Wis.
R. F. Munier — St. Louis, Mo.
J. G. Noest — New York, N. Y.
C. T. Pearce — Philadelphia, Pa.
C. P. Potter — St. Louis, Mo.
F. C. Ruhling — Buffalo, N. Y.
M. L. Schmidt — Fort Wayne, Ind.
L. P. Shildneck — Lynn, Mass.
H. R. Sills — Peterboro, Ontario, Canada
F. R. Terrant — Cleveland, Ohio
P. H. Trickey — St. Louis, Mo.
J. J. Unger — Cleveland, Ohio
R. W. Wieseman — Schenectady, N. Y.

Committee on Substations

K. L. Wheeler, *Chairman;* Cleveland Electrical Illuminating Company, 75 Public Square, Cleveland 1, Ohio
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T. J. Allen — Atlanta, Ga.
Herman Bany — Philadelphia, Pa.
Harris Barber — Boston, Mass.
R. O. Bell — Milwaukee, Wis.
J. L. Buckley — San Francisco, Calif.
H. P. Cadario — Toronto, Ontario, Canada
F. J. Chapin — Albany, N. Y.
C. C. Crane — Madison, Wis.
R. O. Ericson — Hammond, Ind.
J. W. Er.en — Los Angeles, Calif.
C. S. Fiske — Baltimore, Md.
R. F. Gibbons — Santa Clara, Calif.
H. F. Gidlund — Denver, Colo.
P. F. Hargreaves — Seattle, Wash
E. M. Hunter — Schenectady, N. Y.
S. C. Killian — Chicago, Ill.
N. G. Larson — Chicago, Ill.
W. M. Larson — Minneapolis, Minn.
F. W. Linder — Lacrosse, Wis.
F. J. Maas — Portland, Oreg.
W. M. McCauley — Greensburg, Pa.
J. V. McGuire — Milwaukee, Wis.
J. L. McKee — New York, N. Y.
K. E. Personius — Elmira, N. Y.
P. R. Pierson — East Pittsburgh, Pa.
M. E. Reagan — East Pittsburgh, Pa.
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O. J. Rotty — St. Louis, Mo.
W. S. Scheering — Springfield, Mass.
C. H. Smoke — Portsmouth, Va.
P. R. Sprowl — Sharon, Pa.
R. F. Stevens — Portland, Oreg.

Committee on Switchgear

R. L. Webb, *Chairman;* Consolidated Edison Company of New York, Inc., 4 Irving Place, New York, N. Y.
J. D. Wood, *Vice-Chairman* — Philadelphia, Pa.
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C. E. Asbury — Jackson, Mich.
C. H. Baker — Chicago, Ill.
R. M. Bennett — Philadelphia, Pa.
J. S. Brown — Pittsburgh, Pa.
W. B. Brown — Peterborough, Ontario, Canada
B. M. Carothers — St. Louis, Mo.
E. A. Childerhose — Boston, Mass.
H. W. Codding — Newark, N. J.
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G. K. Ditlow — Washington, D. C.
W. E. Enns — Portland, Oreg.
K. J. C. Falck — Philadelphia, Pa.

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W. G. Hoover — Stanford, Calif.
C. L. Killgore — Denver, Colo.
I. T. Knight — Kansas City, Mo.
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H. L. Lowe — New York, N. Y.
D. J. Marsden — San Francisco, Calif.
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F. N. McClure — East Pittsburgh, Pa.
W. J. McLachlan — Schenectady, N. Y.
E. F. Miller — Davenport, Iowa
V. G. Muznay — Schenectady, N. Y.
H. V. Nye — West Allis, Wis.
L. M. Robertson — Denver, Colo.
E. K. Sadler — Los Angeles, Calif.
A. W. Shelhorse — Atlanta, Ga.
O. L. Sidenfaden — Los Angeles, Calif.
J. F. Sinnott — San Diego, Calif.
C. M. Skooglund — Pittsburgh, Pa.
Garland Stamper — Dayton, Ohio
E. A. Stroberg — Boston, Mass.
Anthony Van Ryan — South Milwaukee, Wis.
J. H. Vivian — Los Angeles, Calif.
C. P. West — East Pittsburgh, Pa.
W. F. Wetmore — Detroit, Mich.
J. C. Woods — Chicago, Ill.
S. W. Zimmerman — Ithaca, N. Y.

Committee on System Engineering

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D. W. Alden — Pawtucket, R. I.
J. F. Armstrong — El Paso, Tex.
G. E. Bishop — Santa Cruz, Calif.
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E. F. Bossuyt — Portland, Oreg.
E. C. Brown — Hartford, Conn.
D. H. Cameron — Kansas City, Mo.
O. E. Charlton — Birmingham, Ala.
I. W. Collins — San Francisco, Calif.
F. B. Elmore — Borger, Tex.
S. B. Farnham — Schenectady, N. Y.
W. B. Fisk — New York, N. Y.
G. D. Floyd — Toronto, Ontario, Canada
A. P. Fugill — Detroit, Mich.
E. E. George — New York, N. Y.
A. C. Hartranft — Philadelphia, Pa.
R. G. Hooke — Newark, N. J.
L. R. Janes — Chicago, Ill.
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C. B. Kelley — Des Moines, Iowa
M. H. Kight — Denver, Colo.
H. J. Klumb — Rochester, N. Y.
R. F. Lawrence — East Pittsburgh, Pa.
L. B. Le Vesconte — Chicago, Ill.
W. B. Loper — Riverside, Calif.
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E. B. Paxton — Schenectady, N. Y.

Industry Committee on Interior Wiring Design

M. M. Brandon — New York, N. Y.

L. G. Peterman — New York, N. Y.

Joint Committee for Development of Statistical Applications in Engineering and Manufacturing

W. P. Dobson — Toronto, Ontario, Canada

National Fire Protection Association, Electrical Section

Robin Beach — Brooklyn, N. Y.

W. B. Kouwenhoven — Baltimore, Md.

Student Branches

Name and Location	District	Counselor (Member of Faculty)
*Akron, University of, Akron, Ohio	2	Kenneth F. Sibila
Alabama Polytechnic Institute, Auburn	4	Albert T. Sprague, Jr.
Alabama, University of, University	4	W. F. Gray
*Alberta, University of, Edmonton, Canada	10	R. E. Phillips
*Arizona, University of, Tucson	8	J. C. Clark
*Arkansas, University of, Fayetteville	7	D. D. Lingelbach
*British Columbia, University of, Vancouver, Canada	9	S. C. Morgan
Brooklyn, Polytechnic Institute of, Brooklyn, N. Y., (Day)	3	F. A. Wahlers
Brooklyn, Polytechnic Institute of, Brooklyn, N. Y., (Evening)	3	Anthony B. Giordano
*Brown University, Providence, R. I.	1	M. F. Gordon
*Bucknell University, Lewisburg, Pa.	2	George Irland
California Institute of Technology, Pasadena	8	Gilbert D. McCann
*California, University of, Berkeley	8	R. A. Bruns
*Carnegie Institute of Technology, Pittsburgh, Pa.	2	George H. Royer
Case Institute of Technology, Cleveland, Ohio	2	Rollin W. Waite
Catholic University of America, Washington, D. C.	2	J. C. Michalowicz
Cincinnati, University of, Cincinnati, Ohio	2	Carl F. Evert, Jr.
Clarkson College of Technology, Potsdam, N. Y.	1	
Clemson A & M College, Clemson, S. C.	4	P. T. Tingley
Colorado A & M College, Fort Collins	6	C. C. Britton
*Colorado, University of, Boulder	6	S. I. Pearson
*Columbia University, New York, N. Y.	3	Walter A. LaPierre
*Connecticut, University of, Storrs	1	V. B. Haas
*Cooper Union, New York, N. Y.	3	E. W. Starr
*Cornell University, Ithaca, N. Y.	1	M. G. Malti
*Delaware, University of, Newark	2	H. S. Bueche
*Denver, University of, Denver, Colo.	6	A. M. Stiles
*Detroit, University of, Detroit, Mich.	5	Guido E. Ferrara
*Drexel Institute of Technology, Philadelphia, Pa.	2	F. C. Powell
Duke University, Durham, N. C.	4	Charles R. Vail
Fenn College, Cleveland, Ohio	2	R. W. Schindler
*Florida, University of, Gainesville	4	Paul H. Nelson
George Washington University, Washington, D. C.	2	Norman Ames
Georgia Institute of Technology, Atlanta	4	E. R. Weston
Howard University, Washington, D. C.	2	R. R. Welch
Idaho, University of, Moscow	9	J. Hugo Johnson
Illinois Institute of Technology, Chicago	5	E. T. B. Gross
*Illinois, University of, Urbana, and Chicago Division, Chicago	5	E. A. Reid
*Iowa State College, Ames	5	G. A. Richardson
Iowa, University of, Iowa City	5	E. B. Kurtz
*Johns Hopkins University, Baltimore, Md.	2	T. Larsen
Kansas State College, Manhattan	7	Earl L. Sitz
*Kansas, University of, Lawrence	7	E. L. Jordon
Kentucky, University of, Lexington	4	Gustavus E. Smith
*Lafayette College, Easton, Pa.	2	J. G. Reifsnyder
Lehigh University, Bethlehem, Pa.	2	H. T. MacFarland
Louisiana Polytechnic Institute, Ruston	7	Leslie M. Dyson
*Louisiana State University, Baton Rouge	4	A. K. Ramsey
Louisville, University of, Louisville, Ky.	4	Miles G. Northrop
*Maine, University of, Orono	1	P. M. Seal
*Manhattan College, New York, N. Y.	3	Robert T. Weil, Jr.
*Marquette University, Milwaukee, Wis.	5	E. W. Kane
*Maryland, University of, College Park	2	L. J. Hodgins
*Massachusetts Institute of Technology, Cambridge	1	Alexander Kusko
Massachusetts, University of, Amherst	1	N. E. Wilson
*Michigan College of Mining and Technology, Houghton	5	G. W. Swenson
*Michigan State College, East Lansing	5	Thomas W. Culpepper
*Michigan, University of, Ann Arbor	5	John J. Carey
Milwaukee School of Engineering, Milwaukee, Wis.	5	R. J. Ungrodt
*Minnesota, University of, Minneapolis	5	Paul A. Cartwright
Mississippi State College, State College	4	Paul B. Jacob, Jr.
*Missouri School of Mines and Metallurgy, Rolla	7	J. W. Rittenhouse
*Missouri, University of, Columbia	7	G. V. Lagu
*Montana State College, Bozeman	9	G. D. Sheckels
*Nebraska, University of, Lincoln	6	E. J. Ballard, Jr.
Nevada, University of, Reno	8	Harold Hendricks
Newark College of Engineering, Newark, N. J.	3	Robert E. Anderson
*New Hampshire, University of, Durham	1	John B. Hraba
*New Mexico College of A & M Arts, State College	7	C. D. Crosno
*New Mexico, University of, Albuquerque	7	Ralph W. Tapy
*New York, College of the City of, New York	3	Harold Wolf
*New York University, New York	3	B. James Ley
*North Carolina State College, Raleigh	4	William Stengey
North Dakota State College, Fargo	5	E. M. Anderson
*North Dakota, University of, Grand Forks	5	Raymond A. Berg
*Northeastern University, Boston, Mass.	1	Roland G. Porter
*Northwestern University, Evanston, Ill.	5	A. H. Wing
Norwich University, Northfield, Vt.	1	
*Notre Dame, University of, Notre Dame, Ind.	5	L. F. Stauder
Ohio Northern University, Ada	2	J. L. Klingenberger
*Ohio State University, Columbus	2	F. C. Weimer
*Ohio University, Athens	2	D. R. Green
*Oklahoma A & M College, Stillwater	7	David L. Johnson
Oklahoma, University of, Norman	7	J. Bruce Wiley
*Oregon State College, Corvallis	9	L. N. Stone
*Pennsylvania State College, State College	2	A. P. Powell
*Pennsylvania, University of, Philadelphia	2	Kenneth A. Fegley
Pittsburgh, University of, Pittsburgh	2	R. C. Gorham
*Pratt Institute, Brooklyn, N. Y.	3	David Witrogan
*Princeton University, Princeton, N. J.	2	C. H. Willis
Puerto Rico, University of, Mayaguez	3	Jose Luis Garcia de Quevedo
Purdue University, Lafayette, Ind.	5	Stephen Freeman, Jr.
*Rensselaer Polytechnic Institute, Troy, N. Y.	1	Emerson D. Broadwell
*Rhode Island, University of, Kingston	1	Robert S. Haas
Rice Institute, Houston, Texas	7	M. V. McEnany
Rose Polytechnic Institute, Terre Haute, Ind.	5	R. D. Strum
*Rutgers University, New Brunswick, N. J.	3	John P. Newton
Santa Clara, University of, Santa Clara, Calif.	8	Henry P. Nettesheim
*South Carolina, University of, Columbia	4	J. Hubert Noland, Jr.
South Dakota School of Mines and Technology, Rapid City	6	Arthur R. Colgan
South Dakota State College, Brookings	5	John N. Cheadle
*Southern California, University of, Los Angeles	8	Dudley C. Lewis
*Southern Methodist University, Dallas, Texas	7	F. W. Tatum
*Stanford University, Stanford, Calif.	8	W. G. Hoover
*Stevens Institute of Technology, Hoboken, N. J.	3	William L. Sullivan
Swarthmore College, Swarthmore, Pa.	2	R. W. Merriam
*Syracuse University, Syracuse, N. Y.	1	Edward Shelton
Tennessee, University of, Knoxville	4	W. O. Leffell
*Texas, A & M College of, College Station	7	N. F. Rode
*Texas Technological College, Lubbock	7	Thomas B. Stenis
*Texas, University of, Austin, and Texas Western College Sub-Branch, El Paso	7	William J. McKune
*Toledo, University of, Toledo, Ohio	2	Taute Yang
Toronto, University of, Toronto, Ont., Canada	10	J. E. Reid
*Tufts College, Medford, Mass.	1	J. L. Warner
*Tulane University, New Orleans, La.	4	James A. Cronvich
Union College, Schenectady, N. Y.	1	Owen G. Owens
United States Naval Academy, Annapolis, Md.	2	D. G. Howard
*Utah, University of, Salt Lake City	9	M. E. Valkenburg
Vanderbilt University, Nashville, Tenn.	4	Walter Criley
Vermont, University of, Burlington	1	R. F. Mosher
*Villanova College, Villanova, Pa.	2	John B. Clothier
Virginia Military Institute, Lexington	4	Lee L. Nichols, Jr.
*Virginia Polytechnic Institute, Blacksburg	4	Claudius Lee
*Virginia, University of, Charlottesville	4	Clifford M. Siegel
Washington, State College of, Pullman	9	O. E. Osburn
*Washington, University of, Seattle	9	F. D. Robbins
Washington University, St. Louis, Mo.	7	Pierre M. Honnell
*Wayne University, Detroit, Mich.	5	Edward L. Fairchild
*West Virginia University, Morgantown	2	Everette C. Dubbe
*Wisconsin, University of, Madison	5	John Baird
*Worcester Polytechnic Institute, Worcester, Mass.	1	Donald C. Alexander
*Wyoming, University of, Laramie	6	R. K. Beach
*Yale University, New Haven, Conn.	1	R. R. Shank
Total Branches—132		

* Joint AIEE–IRE Branches

Sections

Name	District	When Organized	Chairman	Secretary	Secretary's Address
Akron	2	Aug. 12, '20	J. C. Hall	P. W. Berthold	Berthold Elec. & Engg. Co., 368–370 Water St., Akron 8, Ohio
Alabama	4	May 22, '29	J. W. Graff	J. E. Spencer	Southern Bell Tel. & Tel. Co., Phoenix Bldg., Birmingham, Ala.
Arizona	8	Mar. 22, '41	J. E. Redmond	E. A. Lodge	Box 58-A, Country Club Dr., Prescott, Ariz.
Arkansas	7	Apr. 23, '47			
Arrowhead	5	Apr. 23, '47	C. C. Boswell	T. W. Holmes	Minnesota Power & Light Co., 30 West Superior St., Duluth 2, Minn.
Beaumont	7	June 27, '45	W. T. Evans	A. F. Briggs	Sun Oil Company, Beaumont, Tex.
Boston	1	Feb. 13, '03	E. W. Boehne	L. J. Weed	Boston Edison Co., 39 Boylston St., Boston, Mass.
Canton	2	Nov. 5, '47	D. L. Westhoefer	David Kalish	Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Central Illinois	5	June 28, '51	Joseph Spengler	C. L. Eletson	1418 West King St., Decatur, Ill.
Central Indiana	5	Jan. 12, '12	P. B. Ewing	G. R. Gunthrie	Indianapolis Power & Light Co., P. O. Box 1595, Indianapolis, Ind.
Chicago	5	1893	R. R. O'Connor	R. W. Jones	Northwestern University, Evanston, Ill.
Cincinnati	2	June 30, '20	A. E. Cavagnaro	S. T. Bryant	Sheldon Storer & Associates, 307 E. 4th St., Cincinnati 2, Ohio
Cleveland	2	Sept. 27, '07	L. E. Knapp	J. R. Linders	Cleveland Electric Illuminating Co., 75 Public Square, Cleveland 1, Ohio
Columbus	2	Mar. 17, '22	F. H. Knapp	E. K. McCoy	Ohio Bell Tel. Co., 42 East Gay St., Columbus 15, Ohio
Connecticut	1	Apr. 16, '21	F. W. Buck	M. B. Sprague	The Southern New England Tel. Co., 227 Church St., New Haven 6, Conn.
Corpus Christi	7	Oct. 25, '51	J. H. Watts, Jr.	R. M. Eichner	General Elec. Co., 1081½ N. Chaparral, Corpus Christi, Tex.
Dayton	2	June 9, '43	L. H. Henry	J. O. Lang	Dayton Power & Light Co., 25 N. Main St., Dayton, Ohio
Delaware Bay	2	June 1, '52	M. G. Young	O. L. Shorter, Jr.	Delaware Power & Light Co., 600 Market St., Wilmington, Del.
Denver	6	May 18, '15	R. B. Hubbard	A. E. Paige	University of Denver, Denver, Colo.
East Tennessee	4	Sept. 2, '36	Mead Warren, Jr.	C. L. Pittman	Aluminum Co. of America, P. O. Box 465, Alcoa, Tenn.
El Paso	7	Mar. 7, '40	George Yelderman	R. L. Riese	New Mexico A&M College, State College, N. Mex.
Erie	2	Jan. 11, '18	F. D. Reese	G. H. Ramandanes	Pennsylvania Electric Co., 21 West 10th St., Erie, Pa.
Fort Wayne	5	Aug. 14, '08	M. A. Baker	R. K. Drake	514 Dayton Ave., Fort Wayne 6, Ind.
Georgia	4	Jan. 14, '04	C. L. Drummond	E. V. McMahon	Southern Engineering Co., 1000 Crescent Ave., N. E., Atlanta, Ga.
Houston	7	Aug. 17, '28	C. R. Wischmeyer	J. E. Fontaine	Graybar Electric Co., Inc., 1702 Cullen Blvd., Houston, Tex.
Illinois Valley	5	June 30, '45	R. H. Bonney	P. J. Costa	1201 Stratford Drive, Peoria 4, Ill.
Iowa	5	June 29, '29	F. E. Baird	C. C. Doerrie	Westinghouse Electric Supply Co., 1404 Walnut St., Des Moines, Iowa
Ithaca	1	Oct. 15, '02	G. E. Dana	W. R. Jones	Cornell University, Ithaca, N. Y.
Jacksonville	4	Jan. 28, '31	R. E. Walker	W. L. Garlington	P. O. Box 4817, Jacksonville 1, Fla.
Kansas City	7	Apr. 14, '16	J. P. Kealer	A. A. Dahms	Allis-Chalmers Mfg. Co., 1009 Waldheim Bldg., Kansas City 6, Mo.
Lehigh Valley	2	Apr. 16, '21	D. A. Campbell, Jr.	W. C. Seymour	Pennsylvania Power & Light Co., 117 East Broad St., Hazleton, Pa.
Los Angeles	8	May 19, '08	E. W. Rockwell	G. T. Harness	University of Southern California, 3551 University Ave., Los Angeles, Calif.
Louisville	4	Oct. 15, '26	J. G. Lipe	J. D. Warren	Louisville Gas & Electric Co., 311 West Chestnut St., Louisville, Ky.
Lynn	1	Aug. 22, '11	T. C. Sargent	J. R. Macintyre	General Electric Co., 40 Federal St., Lynn, Mass.
Madison	5	Jan. 8, '09	Harry Skiles	Fay Morgan	Wisconsin Bell Tel. Co., Madison, Wis.
Mansfield	2	Mar. 6, '39	J. M. Blackhall	W. H. Blashfield	North Electric Mfg. Co., Galion, Ohio
Maryland	2	Dec. 16, '04	F. Hamburger, Jr.	Paul L. Betz	Consolidated Gas, Elec. & Power Co., Lexington Bldg., Baltimore 1, Md.
Memphis	4	May 22, '30	V. E. Mohler	W. C. Jordan, Jr.	1864 Felix Avenue, Memphis 6, Tenn.
Mexico	7	June 29, '22	J. H. Oimeda	H. V. Molstrom	Apartado Postal 1862, Mexico, D.F., Mexico
Miami	4	Feb. 3, '49	C. O. Grannis	R. L. Poor	Florida Power & Light Co., 25 S. E. 2nd Ave., Miami, Fla.
Michigan	5	Jan. 13, '11	A. P. Fugill	H. E. Crampton	Michigan Bell Tel. Co., 1365 Cass Ave., Detroit 26, Mich.
Milwaukee	5	Feb. 11, '10	E. J. Limpel	J. A. Deubel	Perfex Corp., 500 W. Oklahoma Ave., Milwaukee, Wis.
Minnesota	5	Apr. 7, '02	E. A. Willson	P. A. Cartwright	University of Minnesota, Minneapolis 14, Minn.
Mississippi	4	June 28, '51	T. R. Brock	J. L. Maxwell	Mississippi Power & Light Co., Jackson, Miss.
Montana	9	June 24, '31	C. B. Brown	Frank Holly	Montana Electric Supply, Billings, Montana
Montreal	10	Apr. 16, '43	C. L. Roach	G. H. Gillett	Canadian General Electric Co., Ltd., 1000 Beaver Hall Hill, Montreal, P. Q.
Nashville	4	June 28, '51	J. M. Pinkerton	C. A. McNutt	Corps of Engineers, Power Planning Section, Nashville District, Nashville, Tenn.
Nebraska	6	Jan. 21, '25	C. N. Allen	A. R. Adams	Iowa Power & Light Co., 22 Pearl St., Council Bluffs, Iowa
New Orleans	4	Dec. 8, '33	B. Z. Segall	H. A. Schaeffer, Jr.	2518 Pressburg St., New Orleans 22, La.
New York	3	Dec. 10, '19	J. A. Parrott	J. R. Kerner	Westinghouse Electric Corp., 1180 Raymond Blvd., Newark 2, N. J.
Niagara Frontier	1	Feb. 10, '25	C. J. Brumbaugh	L. J. Murphy	Westinghouse Electric Corp., 814 Ellicott Square, Buffalo, N. Y.
Niagara International	10	Aug. 5, '48	Edward Bond, Jr.	K. McCaskill	86 Orchard Road, Lewiston, N. Y.
North Carolina	4	Mar. 21, '29	W. C. Burnett	C. R. Vail	Duke University, Durham, N. C.
Northeastern Michigan	5	Feb. 2, '50	J. E. Young	G. W. Miller	Kuhlman Electric Co., 1000 Twenty-Sixth St., Bay City, Mich.
Northern New Mexico	7	Jan. 25, '51	H. C. Biggs	M. C. Heffelman	Public Service Co. of New Mexico, Santa Fe, N. Mex.
North Texas	7	May 18, '28	J. L. Pratt	C. F. Crandell	Southwestern Bell Tel. Co., 810 Telephone Bldg., Dallas 2, Tex.
Oak Ridge	4	Feb. 1950	G. A. Holt	W. H. Lee	Box 163, Norris, Tenn.
Oklahoma City	7	Feb. 16, '22	R. L. Jones	Bryce Brady	Oklahoma Gas & Elec. Co., Oklahoma City, Okla.
Ottawa	10	June 23, '49	A. M. Pedersen	W. J. Purvis	National Research Council, Sussex St., Ottawa, Ont., Canada
Panhandle Plains	7	June 12, '47	D. H. Buck	C. R. Garst	J. M. Huber Corp., Box 831, Borger, Tex.
Philadelphia	2	Feb. 18, '03	L. R. Gaty	A. E. Pringle, II	Pringle Electrical Mfg. Co., 1906 North Sixth St., Philadelphia 22, Pa.
Pittsburgh	2	Oct. 13, '02	W. J. Lyman	B. R. Teare, Jr.	Carnegie Institute of Technology, Pittsburgh 13, Pa.
Pittsfield	1	Mar. 25, '04	J. H. Hagenguth	B. A. Cogbill	General Electric Co., 100 Woodlawn Ave., Pittsfield, Mass.
Portland	9	May 18, '09	J. D. Frantz	F. J. Maas	Bonneville Power Administration, P. O. Box 3537, Portland 8, Oreg.
Providence	1	Mar. 12, '20	W. G. Seitzel	G. B. Leathers	General Electric Co., 111 Westminster St., Providence, R. I.
Richland	9	Apr. 23, '48	G. M. Clifton	E. H. Olsen	1005 East Alder St., Walla Walla, Wash.
Ridgway	2	June 26, '52	J. H. Schneider	W. P. Van Vranken	306 Charles St., Ridgway, Pa.
Rochester	1	Oct. 9, '14	R. H. Rankin	F. C. Starr	General Electric Co., 89 East Ave., Rochester 4, N. Y.
Rock River Valley	5	Apr. 23, '47	V. W. Schmidt	J. H. Petersen	2824 Garfield Drive, Rockford, Ill.
Sacramento	8	June 15, '50	A. R. Tanner	E. A. Heath	Sacramento Municipal Utility District, 21st & K St., Sacramento, Calif.
St. Louis	7	Jan. 14, '03	J. S. Malsbary	A. E. Marshall	Monsanto Chemical Co., St. Louis, Mo.
San Diego	8	Jan. 18, '39	A. H. Keith	R. V. Davis	4320 Santa Cruz, San Diego 7, Calif.
San Francisco	8	Dec. 23, '04	J. C. Beckett	W. A. Howe	Westinghouse Electric Corp., 410 Bush St., San Francisco 8, Calif.
Schenectady	1	Jan. 26, '03	H. C. Anderson, Jr.	R. K. Fairley	General Electric Co., Bldg. 37, Room 338, Schenectady 5, N. Y.
Seattle	9	Jan. 19, '04	L. J. Lewis	T. J. Martin	Boeing Aircraft Co., Electrical Lab., Seattle, Wash.
Sharon	2	Dec. 11, '25	T. A. Casey	L. J. Benn	Westinghouse Electric Corp., 469 Sharpsville Ave., Sharon, Pa.
Shreveport	7	June 12, '47	W. C. Morris, Jr.	T. W. Landrum	Westinghouse Electric Corp., P. O. Box 1202, Shreveport, La.
South Bend	5	Feb. 26, '41	A. W. Fraps	Virgil Williams	Westinghouse Electric Corp., 216 East Wayne St., South Bend, Ind.
South Carolina	4	Mar. 2, '40	G. L. Dibble	Oren Long	Southern Bell Tel. & Tel. Co., Owen Bldg., Columbia, S. C.
South Texas	7	May 23, '30	R. A. Nicholson	Aubrey Mollenhauer	City Public Service Board, San Antonio, Tex.
Spokane	9	Feb. 14, '13	W. T. Connolly	L. K. Smith	P. O. Drawer 1445, Spokane 6, Wash.
Springfield	1	June 29, '22	S. H. Magruder	R. E. Begley	Oakes Electric Supply Co., 271 Appleton St., Holyoke, Mass.
Syracuse	1	Aug. 12, '20	A. H. Clark	Bernard Cole	Westinghouse Electric Corp., 700 West Genesee St., Syracuse, N. Y.
Tampa	4	Feb. 1, '52	B. N. Darlington	C. J. Ellis	1206 North A St., Box 3092, Tampa 6, Fla.
Toledo	2	June 3, '07	L. H. Fox	S. J. Tombaugh	General Electric Co., 420 Madison Ave., Toledo 4, Ohio
Toronto	10	Sept. 30, '03	C. E. McWilliam	J. T. Fisher	Bell Telephone Co. of Canada, 76 Adelaide St., West, Toronto 1, Ont., Can.
*Tri-State	2	June 28, '51	John E. Moran	H. C. Willey	International Nickel Co., Huntington, W. Va.
Tulsa	7	Oct. 1, '37	V. J. Sittel	J. H. Heller	Public Service Co. of Okla., 600 South Main St., Tulsa, Okla.
Utah	9	Mar. 9, '17	D. R. Jensen	D. R. Allsop	Westinghouse Electric Corp., 235 West South Temple, Salt Lake City, Utah
Vancouver	9	Aug. 22, '11	F. Noakes	H. O. Bulmer	B. C. Electric Railway Co., Ltd., 425 Carrall St., Vancouver 4, B. C.
Virginia	4	May 19, '22	L. D. Johnson, III	A. I. Osborne	226 Wythe Parkway, Hampton, Va.
Virginia Mountain	4	June 23, '49	J. H. Pharis, Jr.	A. E. Snyder, Jr.	American Viscose Corp., 9th St., S. E., Roanoke 9, Va.
Washington	2	Apr. 9, '03	T. A. O'Halloran	J. O. Pease	Rumsey Electric Co., 517 Southern Bldg., 1425 H St., N. W., Washington, 5, D. C.
West Virginia	2	Apr. 9, '40	L. W. Scott	G. W. Unangst	Appalachian Electric Power Co., 301 Virginia St., E., Charleston, W. Va.
Wichita	7	Sept. 16, '37	O. R. Handa	R. E. Phillips	Kansas Gas & Electric Co., Wichita 1, Kansas
Worcester	1	Feb. 18, '20	W. G. Coleman	D. J. Alla	New England Power Service Co., 66 Faraday St., Worcester, Mass.

Total Sections..... 96 *Change in name to Ohio Valley Section under consideration.

Subsections

Name	Chairman	Secretary	Secretary's Address
Adirondack (Schenectady Section)	A. E. Peltosalo	M. E. Noon	General Electric Co., Hudson Falls, N. Y.
Baton Rouge (New Orleans Section)	C. S. Woodruff	W. S. Syrett	1366 Stephens Ave., Baton Rouge 15, La.
Billings (Montana Section)	S. E. McArthur	R. H. Osborne	U. S. Bureau of Reclamation, Billings, Mont.
Binghamton Area (Ithaca Section)	L. F. McGowan	L. J. Sitterlee	New York State Institute of Applied Arts and Sciences, 227 Washington St., Binghamton, N. Y.
Black Hills (Denver Section)	F. N. Mayer	E. B. Hunt	South Dakota School of Mines, Rapid City, S. Dak.
Boise (Utah Section)	R. E. Alworth	D. L. Andrews	Idaho Power Company, Boise, Idaho
Boulder City (Los Angeles Section)	L. J. Hudlow	C. F. Neuman	651 Avenue I, Boulder City, Nev.
Casper, Wyo. (Denver Section)	W. H. Keating	H. F. Jennings	U. S. Bureau of Reclamation, Box 341, Casper, Wyo.
Central Texas (North Texas Section)	Lee Montgomery	J. V. Gibson	1512 North 21st, Waco, Tex.
Centre County (Pittsburgh Section)	C. B. Holt, Jr.	P. E. Shields	Pennsylvania State College, State College, Pa.
Charleston (South Carolina)			
Charlotte (North Carolina Section)	C. E. Harris	Swaffield Cowan	Factory Insurance Association, 1218 Johnston Bldg., Charlotte, N. C.
Columbia (South Carolina Section)	Jack T. Steppe, Jr.	Frank E. Mendes, III	E. I. du Pont de Nemours & Co., Camden, S. C.
Eastern Shore (Maryland Section)	J. E. Willey, Jr.	R. L. Kingsland	Clearwater, Easton, Md.
Eureka Division (San Francisco Section)			
Fort Worth (North Texas Section)			
Fox River Valley (Milwaukee Section)	D. C. Christison	R. F. Rusch	1812 North Lawe St., Appleton, Wis.
Freeport (Houston Section)	D. S. Sandlin	G. R. Horcher	120 Laurel Street, Lake Jackson, Tex.
Fresno Division (San Francisco Section)	F. S. Taylor	D. G. Hartman	939 N. Van Ness Ave., Fresno, Calif.
Great Falls (Montana Section)			
Hamilton (Toronto Section)	L. G. Stopps	H. L. Cormack	Canadian Westinghouse Co., Ltd., Hamilton, Ont., Canada
Hampton Roads (Virginia Section)	L. E. Rhinesmith	J. W. Peghiny	1318 Stockley Gardens, Norfolk, Va.
Hawaii (San Francisco Section)	W. D. Glaser	J. R. Britton	Hawaiian Electric Co., Honolulu, Hawaii
Hudson Valley Division (New York Section)	D. G. Muir	H. R. Porter	Central Hudson Gas & Elec. Corp., South Road Office, Poughkeepsie, N. Y.
Johnstown (Pittsburgh Section)	A. M. Dawson	G. W. Murdock	Pennsylvania Electric Co., Johnstown, Pa.
Lake Charles (Beaumont Section)	C. J. Valdez	G. C. Carroll	Mathieson Chemical Corp., Lake Charles, La.
Lancaster-York (Maryland Section)	G. E. Conn, Jr.	E. M. Elias	Pennsylvania State Technical Institute, 517 Carlisle Ave., York, Pa.
Lima (Dayton Section)	R. J. Sullivan	W. R. Bennet	Westinghouse Electric Corp., Wapak Road, Lima, Ohio
Mid-State (North Carolina Section)			
Mobile-Pensacola (Alabama Section)	S. A. Elliott	E. B. Henry	R. F. D. 3, Box 470, Pensacola, Fla.
Muscle Shoals (East Tennessee Section)	E. B. Foster		
New Hampshire (Boston Section)	J. C. Robinson, Jr.	J. L. Evans	Public Service Co. of N. H., 1087 Elm St., Manchester, N. H.
New Jersey Division (New York Section)	A. G. Smith	Paul Ward	General Electric Co., 744 Broad St., Newark 2, N. J.
Northwest Arkansas (Arkansas Section)	N. H. Barnette	S. C. Smith	Southwestern Gas & Elec. Co., Fayetteville, Ark.
Pecos Valley (El Paso Section)	D. R. Bittner	H. F. Howard	New Mexico Electric Service Corp., Hobbs, N. Mex.
Quad-Cities (Iowa Section)	G. F. Fisher	C. L. Allender	Iowa-Illinois Gas & Elec. Co., Davenport, Iowa
Racine-Kenosha (Milwaukee Section)			
Red River Valley Division (Minnesota Section)	K. B. MacKichan	C. J. Johnston	Northwestern Bell Tel. Co., 105 N. 5th St., Fargo, N. Dak.
Richmond (Virginia Section)	D. N. Rice	J. A. Ritchie	1006 Greenway Lane, Richmond, Va.
St. Lawrence International (Syracuse Section)	L. F. Price	Joel Tompkins	Aluminum Co. of America, Massena, N. Y.
St. Maurice Valley (Montreal Section)	H. Westman	A. McN. Wood	Shawinigan Water & Power Co., Shawinigan Falls, P. Q., Canada
San Jose (San Francisco Section)	J. A. Wells	F. E. Miller	Pacific Gas & Elec. Co., Salinas, Calif.
Savannah (Georgia Section)	E. B. Dawson	P. E. Seawright	Savannah Elec. & Power Co., Bay & Whitaker Sts., Savannah, Ga.
Shasta Division (San Francisco Section)	C. R. Machen	E. B. Wasmuth	U. S. Bureau of Reclamation, Redding, Calif.
Tacoma (Seattle Section)	H. A. Brenner	R. J. Frazen	1120 N. Junett, Tacoma 6, Wash.
Vancouver Island (Vancouver Section)	G. F. Green	L. A. Patterson	British Columbia Power Commission, Victoria, B. C., Canada
West Central Texas Division (North Texas Section)	J. G. McKeown	A. C. Mierow	Central & South West Operating Committee, Utilities Bldg., Abilene, Tex.
West Michigan (Michigan Section)	T. F. Knapp	R. Bosemeyer	924 Knapp N.E., Grand Rapids, Mich.
Youngstown (Sharon Section)	E. A. Mort	J. H. Shepp, Jr.	General Electric Co., 403 N. Main St., Niles, Ohio
Zanesville (Columbus Section)	John Audi	J. C. Joublanc	247 Florence Ave., Zanesville, Ohio

Total Subsections 50

Geographical District Executive Committees

District	Chairman (Vice-President, AIEE)	Secretary (District Secretary)	Chairman, District Committee on Student Activities
1 North Eastern	W. Scott Hill, General Electric Co., T. & A. P. Dept., 100 Woodlawn Ave., Pittsfield, Mass.	G. J. Crowdes, Simplex Wire & Cable Co., 66 Sidney St., Cambridge, Mass.	R. G. Porter, Northeastern University, 316 Huntington Ave., Boston, Mass.
2 Middle Eastern	J. C. Strasbourger, Cleveland Elec. Illuminating Co., 75 Public Square, Cleveland 1, Ohio	J. L. Fuller, Reliance Elec. & Engg. Co., 1088 Ivanhoe Rd., Cleveland 10, Ohio	Tsute Yang, University of Toledo, Toledo 6, Ohio
3 New York City	M. D. Hooven, Public Service Elec. & Gas Co., 80 Park Place, Newark 1, N. J.	J. P. Neubauer, Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York 3, N. Y.	W. A. LaPierre, Dept. of Elec. Engg., Columbia University, New York 27, N. Y.
4 Southern	E. S. Lammers, Jr., Westinghouse Electric Corp., 1299 Northside Drive, N.W., Atlanta, Ga.	C. P. Almon, Jr., Tennessee Valley Authority, 707 Power Bldg., Chattanooga 2, Tenn.	M. G. Northrop, University of Louisville, Speed Scientific School, Louisville 8, Ky.
5 Great Lakes	W. L. Cassell, Dept. of Elec. Engg., Iowa State College, Ames, Iowa	Hubbell Carpenter, Minn. Power & Light Co., 30 W. Superior St., Duluth 2, Minn.	E. B. Kurtz, Dept. of Elec. Engg., University of Iowa, Iowa City, Iowa
6 North Central	F. W. Norris, Elec. Engg. Dept., University of Nebraska, Lincoln 8, Nebr.	R. M. Ibata, Dept. of Elec. Engg., University of Nebraska, Lincoln 8, Nebr.	R. K. Beach, University of Wyoming, Laramie, Wyo.
7 South West	C. M. Lytle, Kansas City Power & Light Co., Box 679, Kansas City 10, Mo.	R. M. Goar, Black & Veatch, 4706 Broadway, Kansas City, Mo.	D. L. Johnson, Dept. of Elec. Engg., Oklahoma A & M College, Stillwater, Okla.
8 Pacific	N. M. Lovell, Tucson Gas, Elec. Light & Power Co., Tucson, Ariz.	Fred Mahler, P. O. Drawer 869, Phoenix, Ariz.	G. D. McCann, California Inst. of Technology, Pasadena 4, Calif.
9 North West	Thomas Ingledew, British Columbia Electric Co. Ltd., 425 Carrall St., Vancouver, B. C.	H. O. Bulmer, British Columbia Electric Co. Ltd., 425 Carrall St., Vancouver, B. C.	J. H. Johnson, University of Idaho, Moscow, Idaho
10 Canada	W. R. Way, Shawinigan Water & Power Co., 600 Dorchester St. West, Montreal 2, Que.	L. K. Hart, Square D Co. of Canada Ltd., 5012 Western Ave., Montreal 28, Que.	

NOTE: Each District Executive Committee includes also the chairman and one other officer (selected by the Section's executive committee) of each Section within the District, the District Vice-Chairman of the AIEE Membership Committee, and a member of the Sections Committee who is resident in the District.

OF CURRENT INTEREST

New Walkie-Lookie Televises Close-ups at Recent Political Conventions

The "walkie-lookie," compact battery-operated back-pack television transmitting equipment, popularly called the "creepie-peepie," was used for close-ups for the first time by the National Broadcasting Company in its television network coverage of the national Presidential conventions.

Developed experimentally by the Radio Corporation of America (RCA), this television counterpart of the military walkie-talkie received its first test as a means of originating television broadcasts in Chicago, Ill., in July.

Walkie-lookie takes close-up of happenings on the floor of the convention. Man at top operates pickup antenna and reflector for walkie-talkie

The equipment consists essentially of a miniature television camera, designed around the new RCA Vidicon pickup tube, and a small 1-piece television transmitter and transmitting antenna which a man can carry on his back by means of shoulder straps.

Weighing just over 50 pounds, the walkie-lookie makes possible a degree of freedom and flexibility in television news coverage that never before has been approached. It does for the visual audience what the roving candid microphone does for radio listeners. The operator can televise scenes and events and narrate comment or description at the same time, with no trailing wires or heavy equipment to limit his scope of operation.

The back-pack unit operates in conjunction with a control station which may be located as much as a mile from the camera. Signals corresponding to the scene being televised are transmitted, along with synchronizing impulses to the control station, where the two are combined and the combination signal is transmitted by wire or by microwave relay to the television broadcast station.

The initial version of the walkie-lookie developed at the David Sarnoff Research Center of the RCA Laboratories Division, Princeton, N. J., was demonstrated a year ago. In building the units used at the conventions, RCA Victor engineers adapted the original system so that standard synchronizing signals could be used, allowing pictures picked up by these units to be fed to the national television network.

Since its first demonstration, the walkie-lookie equipment has undergone many engineering improvements. By changing circuitry design, RCA Victor engineers have modified the equipment so that the control station can put out a combination picture and synchronizing signal better suited to use by the broadcast station. Means of stabilizing the portable camera through a built-in crystal have been devised also, obviating the need for transmission of stabilizing pulses from the control station to the camera, which was used formerly. Structural changes in the back-pack transmitter have streamlined the unit, improved ventilation to prevent overhearing of tubes and components, and increased their accessibility for servicing.

The back-pack is carried in knapsack fashion, suspended from the narrator's shoulders by flexible straps. Two small antennas extend from the top of the pack. One is used to transmit the picture signal to the control station, and the other is used to receive voice and control signals from the same points.

The camera is an adaptation of the RCA industrial television camera using the Vidicon tube. As an added feature, the walkie-lookie camera includes a miniature kinescope picture tube which serves as a view finder for the cameraman. Through it, he is able to see an exact reproduction of the scene on which the camera lens is focused.

The creepie-peepie has a power output of

Commentator Morgan Beatty uses walkie-talkie to describe events as walkie-lookie cameraman transmits scene for television audiences

Future Meetings of Other Societies

American Chemical Society. Seventh National Chemical Exposition. September 9–13, 1952. Chicago Coliseum, Chicago, Ill.

American Standards Association. Third National Standardization Conference. September 8–10, 1952. Museum of Science and Industry, Chicago, Ill.

Compressed Air and Gas Institute. October 8–10, 1952. Shawnee Inn and Country Club, Shawnee-on-Delaware, Pa.

Conference and Exhibition on Instruments and Measurements. Swedish Academy of Engineering Sciences and the Association of Technical Physicists. September 23–30, 1952. Stockholm, Sweden.

Eastern Electrical Wholesalers Association. National Electrical Industries Show. October 14–17, 1952. 165th Regiment Armory, New York, N. Y.

Engineering Manpower Commission, Engineers Joint Council–Western Society of Engineers. Conference on Manpower Utilization and National Security. September 7, 1952. Conrad Hilton Hotel, Chicago Ill.

Heat Exchange Institute. September 24–26, 1952. Skytop Lodge, Skytop, Pa.

Illuminating Engineering Society. National Technical Conference. September 8–13, 1952. Edgewater Beach Hotel, Chicago, Ill.

Institute of Traffic Engineers. Annual Meeting. September 8–11, 1952. Hotel Sherman, Chicago, Ill.

Instrument Society of America. National Instrument Conference and Exhibit. September 8–12, 1952. Cleveland, Ohio.

National Electronics Conference. Eighth Annual Conference. September 29–October 1, 1952. Sherman Hotel, Chicago, Ill.

The American Society of Mechanical Engineers. Fall Meeting. September 8–11, 1952. Sheraton Hotel, Chicago, Ill.

0.35 watt and works on a frequency between 2,008 and 2,025 megacycles. It has a range of 1 mile unobstructed.

Included in the unit are the battery-operated power supply, deflecting circuits, amplifiers, and a radio receiver for receiving instruction and other essential information from the control point.

Electron-Optical Bench Measures Small Electric and Magnetic Fields

A versatile electron-optical bench has been constructed recently at the National Bureau of Standards (NBS) for the extensive study of electron-optical elements. Carriages for magnetic lenses, mirrors, or prisms, and holders for apertures, objectives, and meshes are arranged appropriately in a vacuum chamber. External positioning controls are also provided, offering three degrees of freedom for each element. The bench was developed by the NBS electron physics laboratory. It has become an integral part of a program devoted to the investigation of extremely small electric and magnetic fields in spaces that heretofore have been inaccessible to conventional types of measurement.[1]

Electron-optical methods have been successfully applied to the measurement of magnetic fields around magnetized recording wires,[2] the fringe fields issuing from ferromagnetic domains, and the space-charge distribution of a d-c cutoff magnetron.[3] Besides being able to measure these fields, the NBS electron-optical bench can be adapted for electron-optical field mapping, as an electron microscope, electron diffraction camera, or any instrument having closely related characteristics.

For simplicity of construction and protection against X rays, the bench is made with an all-metal cylindrical vacuum chamber. It is designed to satisfy the following requirements: 1. To accommodate three carriages for lenses with maximum diameters of 7 inches and four holders for apertures, test objects, and meshes (for use in field mapping). 2. To permit a movement of 10 inches along the axis of the bench and 1/2 inch radially for each component of the system without breaking the vacuum.

One end plate of the electron-optical bench supports the electron gun and is permanently fixed to the cylinder with bolts and a rubber gasket vacuum seal. A heavy dural plate serves as the bed for the electron-optical system and is provided with wheels so that the whole system may be rolled in or out of the chamber. The face plate is sealed against the end of the cylinder by a neoprene gasket compressed by atmospheric pressure. A fluorescent screen, $5^{1}/_{2}$ inches in diameter and 7/8 inch thick, and "Wilson seals," through which pass the connecting shafts that control the motion of the elements, are inserted into the face plate.

Radial adjustment of each element is obtained by properly combining controlled vertical and horizontal motions of the lens carriage and holders, achieved by worm and gear arrangements. The axial position of the carriage is controlled by pushing or pulling the connecting shafts through the Wilson seals. Radial motion is constrained by elastic deformation of phosphor bronze strips instead of sliding surfaces.

Current leads for the electron lenses enter the vacuum chamber through metal-glass seals in the face plate; the conductors are insulated by ceramic beads, which produce less outgassing difficulties than would result if rubber or plastic insulation were used. The lenses available for use in the bench were originally designed for use with the coils out in the atmosphere rather than in a vacuum chamber. Because the coils release large quantities of gas to the vacuum system, a rapid pumping system is needed to maintain a working vacuum under these unfavorable conditions. A large fore-pump brings the pressure in the chamber down to about 10 microns of mercury in about 5 minutes. A 4-inch oil diffusion pump is used to maintain an operating pressure of about 3×10^{-3} micron of mercury, measured by an ion gauge installed near the electron gun.

A conventional 100-kv X-ray power supply, consisting of a voltage doubler circuit and two 50-kv rectifier tubes, is used as the high-voltage supply; the normal operating range is between 20 and 70 kv. The filaments are heated by a high-frequency power supply. Lens currents are supplied from separate power supplies that yield currents up to 500 milliamperes and have a stability of better than 1 part in 10,000. The grid bias for the 100-kv electron gun is obtained from a potentiometer connected across three 45-volt batteries in series.

A large proportion of the measurements made with an electron-optical bench are empirical evaluations of electron-optical systems. In such work the results of one measurement often determine the conditions for the next. Hence, a direct method of measuring the image is preferred because it is faster, less involved, and less expensive than the photographic method of recording results. A specially built low-power traveling telescope, reading to 0.0001-inch and with total travel of $2^{3}/_{4}$ inches, is used to measure the image on the fluorescent screen. Because the NBS bench is designed for use with magnetic lenses, which cause rotation of the image, the measuring telescope is mounted on a turntable. It can be moved a distance of 3 inches either horizontally or vertically so as to keep its center of rotation concentric with that of the image. Thus, all measurements are radial. Variable-intensity side illumination of the reticule reduces the difficulty in seeing the cross hair when the intensity of the pattern on the screen is low.

One of the initial measurements made with the NBS electron-optical bench was

The NBS electron-optical bench being used as an electron diffraction camera (left). The electron-optical lens which produces diffraction is connected to the front of the bench and a cathode-ray tube is inserted to permit visual observation of the transmission pattern. View of the NBS electron-optical bench removed from the vacuum chamber is shown at right. Mounted on the bench are the lenses (open cylinders) and the test objects or aperture mounts (disks)

that of the focal length of a magnetic lens. The lens was of the capacitor type, and the system also included a mesh object and a 10,000-turn objective lens. Diffuse illumination of the object, obtained by applying a thin formvar film and a thin conducting aluminum coating on the source side of the mesh, was used to make the focusing critical. The image distance was held constant throughout the measurements. For a particular accelerating voltage, the object position was adjusted to give approximate focus for different objective currents, the final focus being made by a small adjustment of the current. The focal length was computed from the equation $f = q/(M+1)$, where q is the image distance and M is the magnification.

A graph of focal length versus objective lens currents for different accelerating voltages shows that the maximum error in determining the focal length was about ± 0.01 centimeter. The major limitation on accuracy seems to be the difficulty in setting the cross hair on a point of the mesh image. Improvement of the cross-hair design and development of greater skill in setting may reduce the error due to this source to less than one per cent. The precision with which the image can be focused imposes another limitation. The objective lens and pole piece used in the initial measurement permits the image to be apparently in perfect focus over a current range of about 6 milliamperes. The center of this range can be located within about ± 2 milliamperes. It is believed that this cannot be much improved without elaborate additions to the equipment. Errors due to small inaccuracies in alignment and to hysteresis are believed to be negligible.

REFERENCES

1. Electron-Optical Bench, **L. Marton et al.** *Journal of Research*, National Bureau of Standards (Washington, D. C.), volume 47, number 6, (RP 2273), page 461.

2. Electron-Optical Shadow Method. *Technical News Bulletin*, National Bureau of Standards (Washington, D. C.), volume 33, number 9, September 1949, page 106.

3. Electron-Optical Mapping of the Space-Charge Field in a Magnetron. *Technical News Bulletin*, National Bureau of Standards (Washington, D. C.), volume 34, number 5, May 1950, page 57.

Record Electron and X-Ray Energies Reached in California Synchrotron

Record electron and X-ray energies, as well as a speed never before attained by man-accelerated matter, have been reached in the synchrotron under construction at the California Institute of Technology, Pasadena, for the past 2 years, it was announced recently.

The machine, to be used in penetrating the mysteries of the atomic nucleus, has accelerated electrons to energies of 460 million electron-volts in preliminary operation. At this energy level the electrons were more than 900 times heavier than electrons at rest, in accordance with Einstein's relativity principle, and were traveling only 1/10 of a mile per second (or 60 millionths of one per cent) slower than light. When a 1/8-inch thick lead plate was put in the path of the electron beam for test purposes, 460-million-volt X rays were created, the most energetic ever produced by man.

Next stages of work on the synchrotron will involve raising its output somewhat above 500 million volts and preparing it for research expected to begin sometime this summer or fall. Later, its output is to be increased to around one billion volts. Two other high energy electron machines are under construction: a linear accelerator at Stanford University and a nonferromagnetic synchrotron at the General Electric Company, Schenectady, N. Y.

The previous high in electron energies was between 325 and 340 million volts produced by synchrotrons at the University of California at Berkeley, Cornell University and Massachusetts Institute of Technology, and the University of Illinois' betatron.

In brief, the synchrotron operates as follows: An electron gun shoots bursts of about 100 billion particles into the instrument at each pulse. The electrons travel clockwise around a roughly circular path, held there by a powerful magnetic field. Each time around, their energy is kicked slightly higher in a radio-frequency cavity, until the desired acceleration peak is reached.

For research, the electron beam will be used to bombard plates of platinum, tungsten, or other heavy metals, and thus produce X rays. These X rays, in turn, will be used to bombard various materials for experiments on atomic nuclei. The research will be aimed at a better understanding of the structure of these cores and the tremendous forces that keep their constituent protons and neutrons locked together. These are some of the greatest unknowns in physics today.

The synchrotron is built in the shape of a race track whose outside diameter is 36 feet. The 140-ton electromagnet which keeps the high-speed electrons in their orbit as they are accelerated to ever higher speeds is divided into four quadrants. Each quadrant contains 18 roughly rectangular segments weighing almost 2 tons apiece surrounding a 1-by 3-foot vacuum chamber.

The quadrants are separated by 5-foot straight sections. In three of these are attachments for the pumping system that maintains an almost perfect vacuum in the chamber through which the electrons travel. In the fourth straight section is a radio-frequency cavity.

Electrons are shot into the synchrotron by an external electron gun driven by a high-voltage pulse transformer. They pass through an accelerating tube immersed in oil and are injected into the vacuum chamber (at one of the pump sections) with an energy of about one million volts. Their velocity then is roughly 175,000 miles a second, or about 94 per cent that of light.

The electrons move clockwise around the synchrotron. Each time they reach the radio-frequency cavity they get a 250-volt boost in energy. In 1/4 of a second they will have traveled some 46,000 miles, almost twice around the earth, to reach an energy of one-half billion volts.

At these speeds a powerful magnetic field which increases as their speed increases must be used to keep the electrons from flying out of their orbit. Power for the electromagnet which does this job is supplied by a 7,500-kw motor-generator. As each burst of electrons is shot into the synchrotron the magnetic field is produced by a current which rises steadily from zero to 3,000 amperes in 1/4 second, then decays again to zero as the current flows back through mercury arc rectifiers. These convert electric energy to mechanical energy which is stored in a large motor-driven flywheel until the process is repeated, at the rate of about 70 times a minute.

When the radio-frequency cavity is turned off at peak acceleration of the magnetic field the electrons leave their orbit and strike the target.

Logan Gives Paper at British IES Meeting

Shown from left to right are Dr. S. English, Holophane Ltd., London, England; H. L. Logan (F'43), vice-president, Holophane Company, New York, N. Y.; J. G. Holmes, president, Illuminating Engineering Society, London, England; and W. T. Souter, Holophane Ltd., London, outside the Winter Garden Pavilion, Eastbourne, England, during the Summer Meeting of the British IES where Mr. Logan discussed "Two Frontiers of the Lighting Art"

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

HANDBOOK OF ENGINEERING FUNDAMENTALS. Ovid W. Eshbach, editor. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., second edition, 1952. Various paging, tables, charts, graphs, 8¾ by 5¾ inches, bound. $10. This companion volume to the specialised handbooks of the "Wiley engineering handbook series" contains the fundamental laws, theories, and data which are basic to engineering practice. The revision consists of deletions, additions, and changes indicated by 16 years' experience with the first edition, one significant aspect being the much greater emphasis on the use of the MKS system of units. The subject matter is essentially an extended summary of the principles of mathematics, physics, and chemistry, the commonly used mathematical tables, the properties and uses of materials, and the mechanics of solids and fluids. A discussion of engineering law is included.

INDUSTRIAL HIGH VACUUM. By J. R. Davy. Pitman Publishing Corporation, 2 West 45th Street, New York, N. Y., 1951. 243 pages, diagrams, tables, graphs, 8¾ by 6½ inches, bound. $5.50. Intended for both the engineer and physicist, this book deals with the design and manipulation of vacuum installations and gives sufficient basic theory for the understanding of the principles involved. Chapters are included on the application of the plant to industrial purposes, covering the major uses, methods of handling, and control of the products. Numerous special topics such as vacuum metallurgy and vacuum dehydration are briefly considered.

MAC RAE'S BLUE BOOK, 59th EDITION, 1952. MacRae's Blue Book Company, 18 East Huron Street, Chicago, Ill. 4,318 pages, illustrations, 11¼ by 8½ inches, bound. $15. Revised annually, this book is one of the most useful listings of manufacturers and materials of all kinds. It has four sections: address and local distributors' section, classified materials section, chemical section, and trade name section.

ASTM BOOK OF STANDARDS. Including Tentatives. 1951 Supplement. Part 1: Ferrous Metals, 402 pages; 2: Nonferrous Metals, 346 pages; 3: Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing, Soils, 265 pages; 4: Paint, Naval Stores, Wood Adhesives, Paper, Shipping Containers, 253 pages; 5: Textiles, Soap, Fuels, Petroleum, Aromatic Hydrocarbons, Antifreezes, Water, 324 pages; 6: Electrical Insulation, Plastics, Rubber, 233 pages. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1951. Illustrations, diagrams, tables, graphs, 9 by 6 inches, paper. $3.50 each. These supplementary sections contain the extensively revised standards, and the new and extensively revised tentatives in the respective fields, that have been accepted since the appearance of the 1950 supplement. By means of these supplements the results of the standardization activities of the ASTM are made available for the years between the trienniel issues of the complete Book of Standards.

ASTM SPECIFICATIONS FOR STEEL PIPING MATERIALS. Prepared by ASTM Committee *A-1* on steel. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1952. 372 pages, tables, charts, diagrams, 9 by 6 inches, paper. $3.50. This compilation contains all ASTM specifications for carbon-steel and alloy-steel pipe and tubing. It covers pipe to convey liquids, vapors, and gases at normal and elevated temperatures; still tubes for refinery service; and tubes for boilers, heat exchangers, condensers, and superheaters. Specifications are also included for castings, forgings, bolts, and nuts used in piping installations. A number of emergency alternate provisions in separate form are provided with the book or will be sent subsequently.

ASTM STANDARDS ON COPPER AND COPPER ALLOYS. Sponsored by ASTM Committee *B-5* on copper, copper alloys, cast and wrought. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1952. 504 pages, tables, diagrams, 9 by 6 inches, paper. $4.75 (cloth $5.40). The more than 100 standard or tentative methods of test and specifications in this compilation are broadly classified as follows: copper and copper-alloy products for electrical purposes; plate, sheet, strip, and rolled bar; rod, bar, and shapes; copper-alloy wire; pipe and tube; ingots and castings; arc-welding electrodes and brazing solder; methods of test for copper and copper alloys. There have also been added certain selected specifications for nonferrous metals and alloys used in the manufacture of copper-alloy products.

ADVANCED ANTENNA THEORY. (Applied Mathematics Series.) By Sergei A. Schelkunoff. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y., 1952. 216 pages, tables, graphs, 9¼ by 6 inches, bound. $6.50. This rigorous mathematical analysis of recent developments in antenna research stresses physical interpretations of the mathematical methods employed. The six chapters deal respectively with spherical waves, mode theory of antennas, spheroidal antennas, cylindrical antennas, integral equations, and natural oscillations. Special attention is paid to Hallen's asymptotic solutions for thin antennas, Stratton and Chu's solution for spheroidal antennas, and the author's own theory of conical antennas and thin antennas of arbitrary shape.

ANTENNAS: Theory and Practice. (Applied Mathematics Series.) By Sergei A. Schelkunoff and Harald T. Friis. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y., 1952. 639 pages, graphs, charts, 9¼ by 6 inches, bound. $10. This comprehensive treatment of the basic ideas and techniques necessary for an understanding of antenna behavior combines a discussion of antenna principles and the theory of radiation with practical applications. It begins with a broad survey of the entire field, develops and applies the essentials of field theory, considers spherical waves on wires and in free space, and deals with directive radiation and its application to antenna arrays. Power transmission between two antennas and the quantitative theory of wave propagation are discussed. Practical information is given on all types of antennas.

APPLICATION OF THE ELECTRONIC VALVE IN RADIO RECEIVERS AND AMPLIFIERS. By B. G. Dammers and others. Two volumes. Philips Gloeilampenfabrieken, Eindhoven, Netherlands, (available in United States from Elsevier Press Inc., 402 Lovett Boulevard, Houston 6, Tex.), 1950, 1951. 416 pages, 431 pages, graphs, tables, diagrams, charts, 9¼ by 6½ inches, bound. Volume 1: $5, volume 2: $7.75. Constituting books 4 and 5 of the over-all series on electron tubes, these two books are also volumes 1 and 2 of the special series of three with the foregoing title. The comprehensive and detailed description and analysis of the construction, functioning, and application of the tubes involved are divided into the following sections: (volume 1) radio-frequency and intermediate-frequency amplification; frequency-changing; determining the tracking curve; parasitic efforts and distortion due to curvature of tube characteristics; detection; (volume 2) audio-frequency amplification; the output stage; power supply. In presenting this treatise on fundamental theory illustrated by a full complement of definitive examples, all necessary engineering information is supplied, together with the essential mathematical treatment. Volume 3 is to cover feedback, control devices, and other special aspects.

BIBLIOGRAPHY OF PHOTOELECTRIC SPECTROPHOTOMETRIC METHODS OF ANALYSIS FOR INORGANIC IONS. By J. W. Stillman and E. C. Dunlop. American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. (Special Technical Publication Number 125), 1952. 25 pages, 9 by 6 inches, paper. $1.50. This publication brings up to date the similarly titled bibliography which appeared in the 1944 ASTM *Proceedings*. It covers volumes 1 to 23 of the Analytical Edition of Industrial and Engineering Chemistry and volumes 62 to 76 of the Analyst, including part of 1951 in each case. The items are classified according to the metal to be determined, and where a method involves more than one ion the reference appears under each.

FLUORESCENT LIGHTING. Edited by C. Zwikker, Philips' Gloeilampenfabrieken, Eindhoven, Netherlands, (available in United States from Elsevier Press Inc., 402 Lovett Boulevard, Houston 6, Tex.), 1952. 248 pages, illustrations, diagrams, graphs, tables, 9¼ by 6½ inches, bound. $6.25. A review of the scientific and technical fundamentals and of the applications of the fluorescent lamp and its accessories. Owing to the differences between incandescent and fluorescent lamps, emphasis is placed on the specialized design necessary for the most efficient use of fluorescent installations. In addition to full coverage of the principles and operation of fluorescent equipment, many special adaptations are considered.

PAMPHLETS

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Laboratory Design for Handling Radioactive Materials. Sponsored by the American Institute of Architects and the Atomic Energy Commission, this report is the published proceedings of the third research conference of the Building Research Advisory Board. The five main papers, on laboratory layout and construction, shielding, surfaces and finishes, air supply and exhaust, and waste disposal, with accompanying panel speeches and general discussion, are included. Also included are an extensive bibliography and a glossary of terms used in nuclear science and technology. 140 pages, including illustrations. $4.50 per copy. Available from Building Research Advisory Board, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

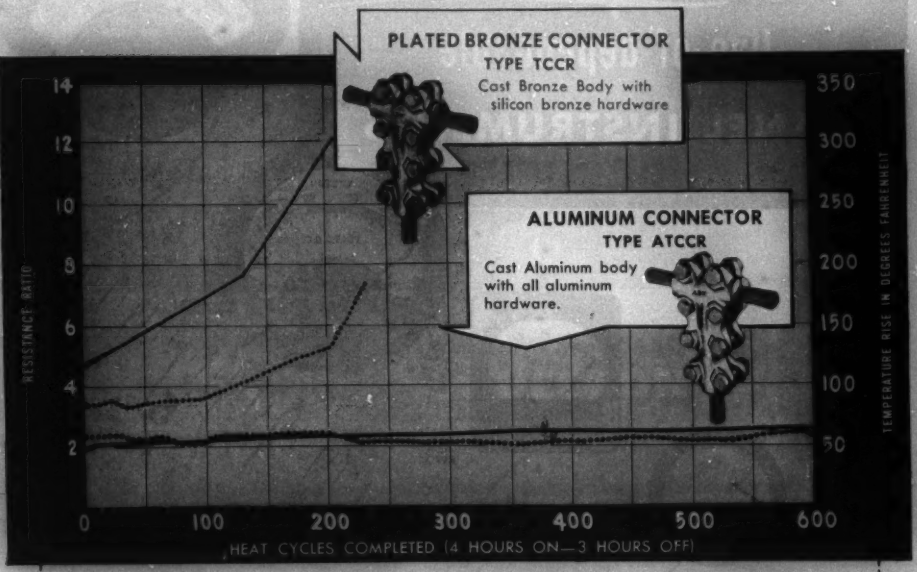
Manual for Underwater Welding. Developed by the Navy Engineering Experiment Station, the manual discusses such phases of procedure as: choosing the proper electrode size; strength of underwater welds; fitting up; surface cleaning; conditions adverse to underwater welding; techniques for fillet welding in vertical, overhead, and horizontal; and safety measures. 28 pages, including illustrations. 75¢ per copy. Available from the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.

Street Lighting Engineering Guide. Prepared by the Westinghouse Electric Corporation, the booklet starts with such fundamental considerations as the purposes of street lighting and the quantity of light required, and builds up to more involved discussions on design procedures, roadway illumination computations, and electric distribution systems. Sample problems and their step-by-step solutions are given in the computations section. 84 pages, including charts, diagrams, photographs, and glossary. Available from Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.

Survey of Radio-Frequency Transmission Lines and Wave Guides. Volume 28, number 2 of the Proceedings of The Radio Club of America, this publication contains an historical survey, plus essential technical data from published articles between 1919 and 1936, followed by a bibliography through 1951. $1.50 per copy. 88 pages, including illustrations. Available from The Radio Club of America, 11 West 42d Street, New York 18, N. Y.

NEMA Standards for Lightning Arresters. This publication covers the rating, manufacturing, performance, testing, application, and selection of station-valve-type, line-valve-type, distribution valve—and expulsion-type, and secondary valve-type lightning arresters. 44 pages. $2.50 per copy. Available from the National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N. Y.

CONNECTOR FAILURES Result from the Difference in Coefficient of Expansion of Dissimilar Metals



LEGEND
PLATED BRONZE CONNECTOR
——— RESISTANCE RATIO
..... TEMPERATURE RISE

HEAT CYCLE TEST ON CONNECTORS FOR 1,000,000 cm ALUMINUM CABLE

LEGEND
ALL ALUMINUM CONNECTOR
——— RESISTANCE RATIO
..... TEMPERATURE RISE

RESISTANCE RATIO:

This is the ratio of the apparent contact resistance of the fitting to the resistance of a piece of 1,000,000 cm aluminum cable of the same length as the length of contact.

- CABLE—1000 MCM Insulated all aluminum 61 x 0.1280 stranding
- HEAT CYCLE CURRENT—785 Amperes
- AVERAGE AMBIENT TEMPERATURE—70° to 80° F
- AVERAGE TEMPERATURE OF CABLE ABOVE AMBIENT—66° F

Be sure to specify **Cast Aluminum Connectors with Aluminum Hardware when Connecting Aluminum Conductors**

Consult one of our nearest 18 representatives or contact our main office

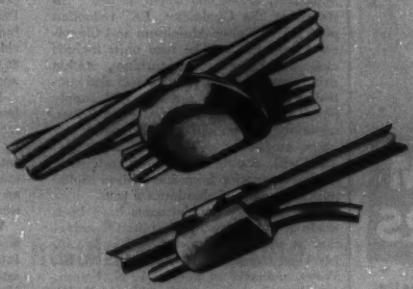
ANDERSON BRASS WORKS, Inc.
POST OFFICE DRAWER 2151
BIRMINGHAM, 1, ALABAMA

The most *Comprehensive* line of dependable PANEL INSTRUMENTS

There are no blanks in the WESTON line of panel instruments. It includes all the sizes . . . all the types, ranges, sensitivities, too. Many specials, as well; developed to meet unusual requirements. All are built in the finest WESTON tradition for sustained accuracy over years of dependable service. Your local WESTON representative will gladly cooperate on any panel instrument problem, or write direct to . . . WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey . . . *manufacturers of Weston and Tag instruments.*

WESTON PANEL *Instruments*

797

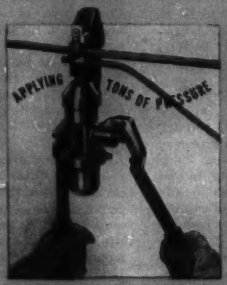


NOW Reduce Your Connector Cost by 50% with the New Kearney SQUEEZON

A Completely New Type Connector That Eliminates Contact Corrosion

In the face of rising costs throughout the industry, management men will appreciate the savings effected through this advanced design connector.

The men in the field too approve of the many advantages provided in this revolutionary method of line connections. The results are better—installation is easier.



Here's How It Works . . .
A CLICK—and It's Done!

The KEARNEY SQUEEZON is a pure copper compression-type connector forged in a shape having an "H" cross-section. The connection is made by placing one conductor in the top half of the "H" and the other in the bottom. The sides are then coined over under tremendous hydraulic pressure—applied by pumping one handle of the SQUEEZON Tool. When a distinct click is heard the connection is then complete, permanent and a perfect electrical bond.

WRITE TODAY for the big, 8-page bulletin on the Squeezon.

JAMES R. KEARNEY CORPORATION
4224-42 Clayton Avenue • St. Louis 10, Missouri
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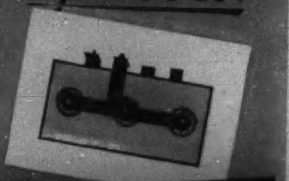
JAMES R. KEARNEY CORPORATION ST. LOUIS, MO.

KEARNEY Gives a Little More for a Little Less *Through Engineering*

SYNTRON



SELENIUM RECTIFIERS

Made by a new vacuum process that insures a smooth, uniform selenium film, free from flaws and impurities, and permits the production of larger cells than have been practical heretofore.

Of proven dependability to withstand continuous heavy-duty service, they are available in one inch square to 12 by 16 inch cells, in standard stacks or for customer assembly.

WRITE FOR FREE CATALOG FOLDER

SYNTRON CO.

140 Lexington Ave. Homer City, Pa.

Measurements Corporation
MODEL 78

STANDARD SIGNAL GENERATORS

FREQUENCY RANGE: Choice of two bands; frequency ratio of each band 1.8 to 1 within range of 10 Mc. to 250 Mc. Special single band instruments also available up to 420 Mc.

OUTPUT VOLTAGE: Continuously variable from 1 to 100,000 microvolts.

MODULATION: AM, fixed at 30%.

POWER SUPPLY: 117 v., 50/60 cycles.

MEASUREMENTS CORPORATION

BOONTON NEW JERSEY

INDUSTRIAL NOTES ....

General Electric Notes. General Electric apparatus, $8,000,000 worth, is being installed at the Chalmette, La., reduction plant of the Kaiser Aluminum and Chemical Corporation. The new units include nine 20,000-kw steam turbines, station switchgear, and auxiliary motors and control. Eight of the turbines will supply power for Chalmette's four new potlines, while the other will provide power for plant auxiliaries. The four additional lines will double the plant's originally designed capacity from 200 million to 400 million pounds of aluminum a year.

The following appointments have been made at the Accessory Turbine Organization at the Lynn River Works: W. O. Meckley, manager of engineering; H. M. Wales, manager of sales; T. N. Ferren, superintendent of manufacturing; F. W. Dahlberg, facilities engineer; J. W. Shirley, production manager; A. C. Eastman, supervisor of inspection.

The atomic-energy activities of the company, including the plutonium plant at Hanford, Wash., and the Knolls Atomic Power Laboratory, Schenectady, N. Y., have been centralized under the Defense Products Group. Already operating within the group is the Aircraft Nuclear Propulsion Project. Under the regrouping, G. R. Prout has been appointed vice-president of nucleonic and atomic projects with headquarters in Schenectady. Mr. Prout also will serve as vice-president in charge of the Nucleonics Division and vice-president and general manager of a newly-established Atomic Projects Division within the Defense Products Group. W. E. Johnson has been named general manager with headquarters at Hanford, and K. E. Kingdon and K. R. Van Tassel remain as technical manager and general manager, respectively, of the Knolls Atomic Power Laboratory.

The first occupants of "Appliance Park," the multimillion-dollar manufacturing center, moved into the Louisville project recently. About 200 employees of the range and water heater and home laundry equipment departments moved into the nearly finished office sections of buildings 1 and 2. The first manufacturing operations at the new plant are scheduled for late this year.

The name of the General Electric Supply Corporation has been changed to General Electric Distributing Corporation. The new corporation will have two operating divisions. One, to be known as the General Electric Supply Company, will carry on the business of the old Supply Corporation. The other, General Electric Appliances Company, will carry on a G-E appliance distributing business along the lines of that formerly conducted by General Electric Appliances, Inc. Personnel of the two divisions of the new corporation will remain unchanged.

Westinghouse News. A $32,000,000 expansion program that will take about a year to complete is under way at the South Philadelphia (Pa.) Works of the company. The project involves reoccupancy, under lease agreement, of the Navy-owned Merchant Marine plant adjoining the South Philadelphia Works, extensions to existing buildings, extensive purchases of new machine tools, and a previously announced $6,000,000 steam- and gas-turbine research and development laboratory.

Dr. John W. Marden, Westinghouse lamp division research scientist, recently received the highest civilian award given by the Department of the Army, the Certificate of Appreciation. The award was made in recognition of his development of an alloy for lining barrels of automatic weapons.

W. L. Carroll has been elected treasurer and a director of the Westinghouse Electric International Company. He has been assistant treasurer since 1945. K. I. Horgan has been appointed Eastern District manager of the Industrial Division, and F. G. Graf and J. J. Feldman have been named manager and assistant manager, respectively, of the Eastern District Agency and Construction Department. Other appointments announced were C. R. Potter as manager of commercial engineering, Electronic Tube Division; J. R. Fox, sales application engineer for the North Central territory of the Electronic Tube Division, and C. F. Trapp, area manager for the Detroit branch office.

Arthur W. Sullivan, general advertising manager, retired on June 30. He had been with Westinghouse since 1937.

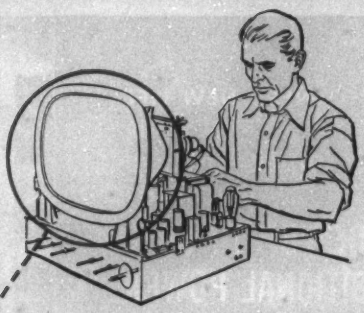
RCA Developments. The first mobile television unit for use by the Dominican Republic was delivered recently by the Radio Corporation of America. The mobile unit, which includes field cameras, monitors, microwave relay equipment, and other remote television facilities, has been purchased for use by "La Voz Dominicana," a Dominican broadcast and television organization.

Laconia, N. H., became the first city in New England to receive television with the RCA "Antenaplex" system of community reception. The Antenaplex system will permit residents of Laconia to make cable connection to a central antenna installed atop Mount Belknap, 6 miles east of the city. Television signals transmitted over mountainous terrain from Boston, Mass., 120 miles away, emerge as clear and stable pictures on receivers in Laconia.

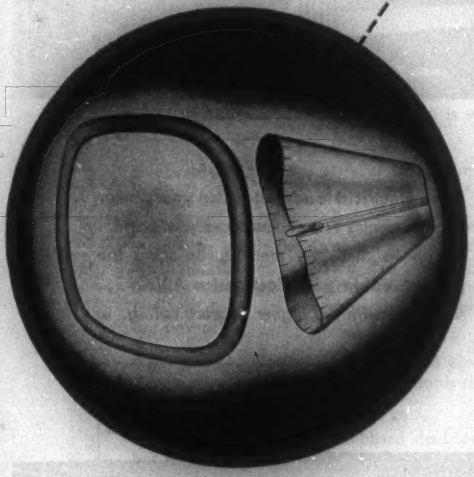
A separate kinescope and receiving tube sales function within the renewal sales organization has been established. K. B. Shaffer has been appointed manager of kinescope renewal sales, and D. M. Branigan will continue as manager of receiving tube renewal sales.

Edward Stanko has been appointed to the newly created post of manager of engineering, technical products division, RCA Service Company, Inc. He will direct specialized training of field personnel, preparation of technical information, and development of new and improved methods for installation and servicing of RCA technical products.

(*Continued on page 24A*)



Du Pont "Alathon"* insulates TV tube carrying 20,000 volts



Rings and sleeves extruded by
Anchor Plastics Co., Inc.
New York, N. Y.

*REG. U.S. PAT. OFF.

DU PONT
REG. U.S. PAT. OFF.
150th Anniversary
Better Things for Better Living
...through Chemistry
Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

Ring and sleeve of "Alathon" retain dielectric properties . . . pass humidity tests . . . lower shipping costs

When television-set manufacturers started using metal picture tubes, they were faced with the problem of insulating the outer portion of the tubes that carry up to 20,000 volts. A material was needed that could withstand the voltage, while resisting humidity that would ruin its insulating value.

The solution was this ring and sleeve extruded of Du Pont "Alathon" polythene resin. Of all the materials tested, only "Alathon" retains its electrical properties in service. "Alathon" has excellent dielectric strength, low dielectric constant (2.3), and low power factor (0.0005). Because of its very low moisture-absorption rate (0.01% by A.S.T.M. test), "Alathon" easily passed exacting humidity tests.

Du Pont "Alathon" offers other important advantages. Its flexibility simplifies installation. Shipping costs are reduced because "Alathon" absorbs shock . . . makes possible packing of sets as units . . . eliminates shipping the delicate tubes separately. And reassembly time and labor at outlets are eliminated. Many TV manufacturers now use these rings and sleeves.

Du Pont "Alathon" is widely used for such insulating applications as TV lead-in wire, high-voltage TV lead wire, and police and fire-alarm cable. We will gladly suggest suppliers who can meet your specific needs for electrical or other uses of "Alathon." For further information, write:

E. I. du Pont de Nemours & Co. (Inc.)
Polychemicals Department, District Offices:
350 Fifth Avenue, New York 1, New York
7 S. Dearborn St., Chicago 3, Illinois
845 E. 60th St., Los Angeles 1, California

NEED NEW LIFE IN YOUR UNDER-POWERED BUILDING?

GET UP TO 50% ADDITIONAL POWER

WITH

ROCKBESTOS A.V.C.®

WITHOUT REPLACING PRESENT CONDUIT

Here's How You Benefit

Use Same Size Cable . . . get ⅓ to ½ more current.

Use Present Conduit and Fittings . . . save on steel.

Installation Costs Are Low . . . cable size remains the same, is easy to pull through conduit. Using present conduit eliminates costly installation.

No Building Repairs . . . because you use existing conduit, there are no walls to repair, no weakened beams or partitions to repair.

A Time Saver . . . Old buildings or new, Rockbestos A.V.C. is a dollar-saver, and time-saver. Write for booklet "Rx for a Building with Hardening of the Electrical Arteries."

Have electrical loads outgrown your power requirements? You can increase your capacity up to 50% by merely replacing the present cable with Rockbestos A.V.C. . . . *the cable with the higher ampere rating.*

IT'S THE **A.V.C.** "SANDWICH" THAT MAKES THE DIFFERENCE

This "sandwich" protects the varnished cambric. It enables A.V.C. to carry more current than cables with conventional insulations.

Outer Felted Asbestos Wall	Varnished Cambric	Inner Felted Asbestos Wall

ROCKBESTOS PRODUCTS CORPORATION

NEW HAVEN 4, CONN. • **the originators of A. V. C.®**

New York • Cleveland • Detroit • Chicago • Pittsburgh • St. Louis
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HI ... *Your best buy*

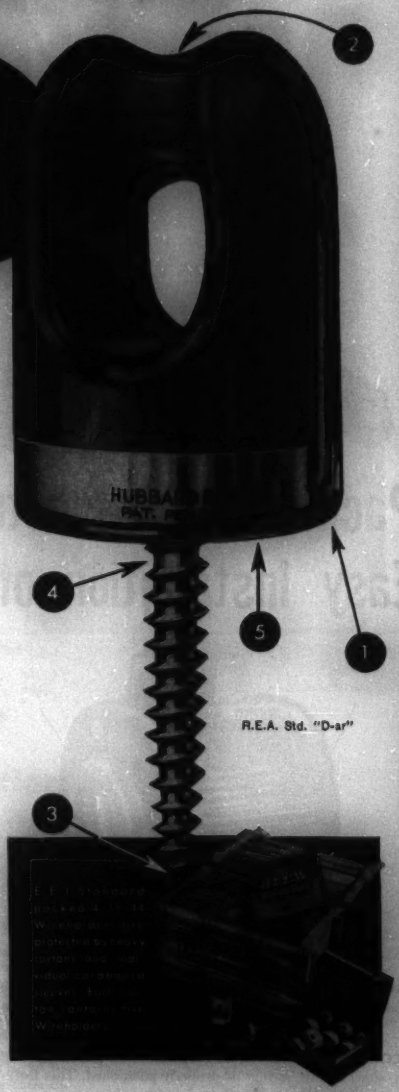
LET'S TALK WIREHOLDERS . . .

HUBBARD 4-11-44 *has what it takes*

No other wireholder combines so many desirable features as the famous HUBBARD 4-11-44 . . . advantages which have been proven in millions of installations.

HERE'S THE LIST....

1. Designed so that the heavy Copperweld bail takes all the tension . . . the porcelain is subjected to compression only.
2. The smoothly rounded surfaces avoid damage to insulation.
3. The special wood screw is sharp-pointed, easy to start by hand; the threads are sharp, deep, clean-cut, for fast insertion. No other wireholder screw on the market can match the Hubbard design for ease of installation or holding power.
4. The thread is cut clear to the base, and gives a strong grip, even in material considerably thinner than the length of the screw.
5. The heavy steel base is Hubbard double-dip hot galvanized, to effectively prevent corrosion or rust streaks; the 4-11-44 is built to resist the elements through the years. There are no closed pockets to retain moisture and dirt that cause unsightly streaks.



Exhaustive tests have proved that the Hubbard 4-11-44 has the greatest dead-end strength of any wireholder manufactured, plus sufficient strength on angular attachments to provide proper margins of safety over any load which would be encountered consistent with approved engineering practice.

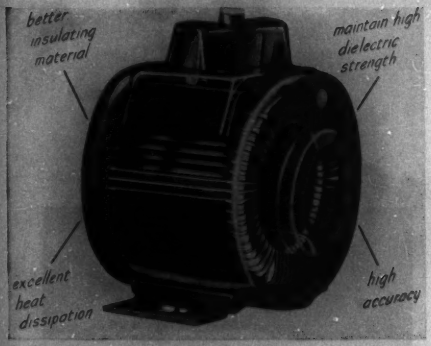
HUBBARD AND COMPANY

ESTABLISHED 1843

PITTSBURGH • CHICAGO • OAKLAND, CALIFORNIA

"Hang the load on Hubbard Hardware!"

Pacific Gas & Electric Company Benefits from Easy Installation of G-E Current Transformer



INSULATION, SUPPORT, AND CASING are of molded butyl. Laboratory and service tests have proved butyl resists weather.

Less Breakage with Butyl-molded Indoor-Outdoor Current Transformer

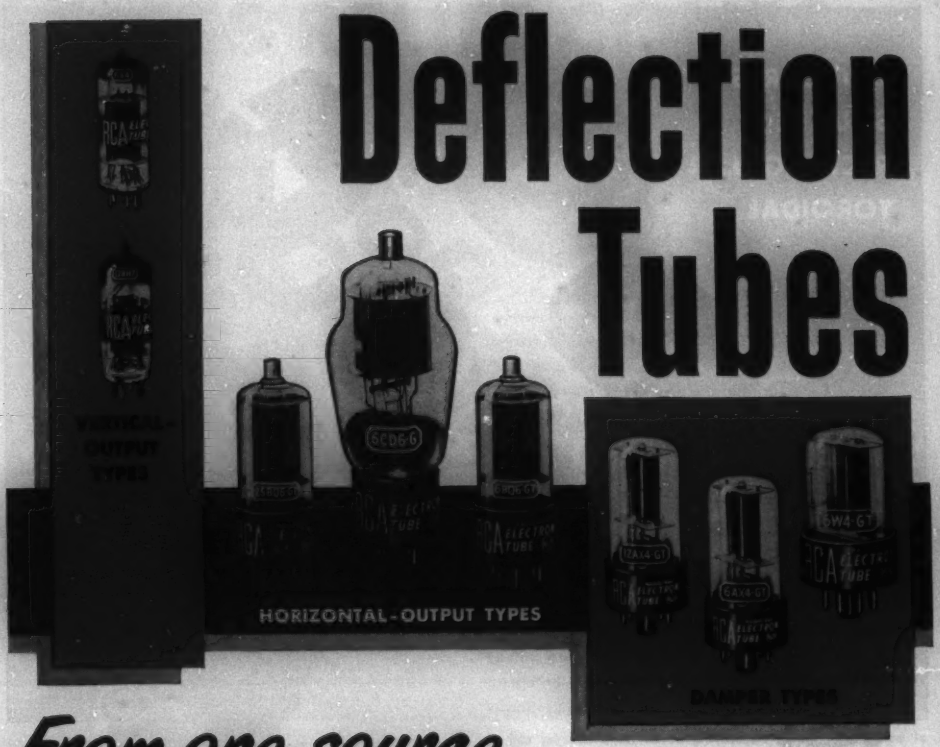
Pacific Gas & Electric Company is currently using the new Type JKP-O butyl-molded indoor-outdoor current transformer extensively for metering 480-volt irrigation pumping loads. The JKP-O greatly simplifies such installations because the transformer design permits the use of continuous leads between mains and weather-heads. The butyl construction also practically eliminates the breakage hazard during installation. For more information contact your local G-E representative or write Section 604-34 for Bulletin GED-1465, General Electric, Schenectady 5, N. Y.

GENERAL ELECTRIC

SECONDARY TERMINAL COVER cannot be put in place unless short-circuit switch is properly positioned. This feature protects both personnel and equipment.

WHEN USED AS THREE-WIRE TRANSFORMER, two conductors are passed through the window. The two-inch window allows easy insertion of full-sized primary cables.

Deflection Tubes



From one source...

8 types to fill your deflection-system needs

RCA now offers these eight volume-type, deflection-system tubes having performance range to take care of most circuit requirements efficiently and economically.

Vertical-Output Tubes: The RCA-6S4 is a miniature medium-mu triode for circuits operating from the boosted B-voltage supply and is capable of supplying ample deflection for kinescopes having diagonal-deflection angles up to 70 degrees and operating at voltages up to 18 kilovolts. The RCA-12BH7 is a miniature twin triode used in similar circuits having more modest deflection-voltage requirements and permits the economy of using one triode unit as the vertical oscillator.

Horizontal-Output Tubes: The RCA-6BQ6-GT beam power tube is capable of fulfilling most requirements for horizontal deflection and high voltage in receivers having B voltages in the order of 230-300 volts. RCA-25BQ6-GT, the same as the 6BQ6-GT except for its 25-volt, 0.3-ampere heater, is for use in receivers having series heater strings. The huskier RCA-6CD6-G has the reserve power desired in deluxe receivers operating at high voltages up to 18 kilovolts.

Damper Tubes: The RCA-6W4-GT has the high perveance needed for efficient operation and good linearity in horizontal-deflection circuits. The RCA-6AX4-GT features higher heater-cathode voltage ratings so that a separate heater supply is not required. RCA-12AX4-GT, identical with the 6AX4-GT except for its 12.6-volt, 0.6-ampere heater, is for use in receivers having series heater strings.

Application Notes: Application Notes covering "Design Considerations for Minimizing Ripple and Interference Effects in Horizontal-Deflection Circuits," and "Horizontal-Deflection-Output and High-Voltage Transformer RCA-230T1 for 18-Kilovolt Kinescope Operation" are yours for the asking. For your copies —and data on these RCA tubes for deflection systems—write RCA, Commercial Engineering, Section IR 39, Harrison, N.J.

For additional information on using these RCA tubes in your circuits contact the nearest RCA Field Office.

FIELD OFFICES: (East) Humboldt 5-3900, 415 S. 5th Street, Harrison, N. J. **(Midwest)** Whitehall 4-2900, 589 E. Illinois Street, Chicago, Illinois. **(West)** Madison 9-3671, 420 S. San Pedro Street, Los Angeles, California.

RCA **RADIO CORPORATION of AMERICA** TMK. ®
ELECTRON TUBES HARRISON, N.J.

Anything You May Need in TAPE-WOUND CORES

RANGE OF MATERIALS

Depending upon the specific properties required by the application, Arnold Tape-Wound Cores are available made of DELTAMAX . . . 4-79 MO-PERMALLOY . . . SUPERMALLOY . . . MUMETAL . . . 4750 ELECTRICAL METAL . . . or SILECTRON (grain-oriented silicon steel).

RANGE OF SIZES

Practically any size Tape-Wound Core can be supplied, from a fraction of a gram to several hundred pounds in weight. Toroidal cores are available in fifteen standard sizes with protective nylon cases. Special sizes of toroidal cores—and all cut cores, square or rectangular cores—are manufactured to meet your individual requirements.

RANGE OF TYPES

In each of the magnetic materials named, Arnold Tape-Wound Cores are produced in the following standard tape thicknesses: .012", .008", .004", .002", .001", .0005", or .00025", as required.

Applications

MAGNETIC AMPLIFIERS
PULSE TRANSFORMERS
CURRENT TRANSFORMERS
WIDE-BAND TRANSFORMERS
NON-LINEAR RETARD COILS
PEAKING STRIPS . . . REACTORS.

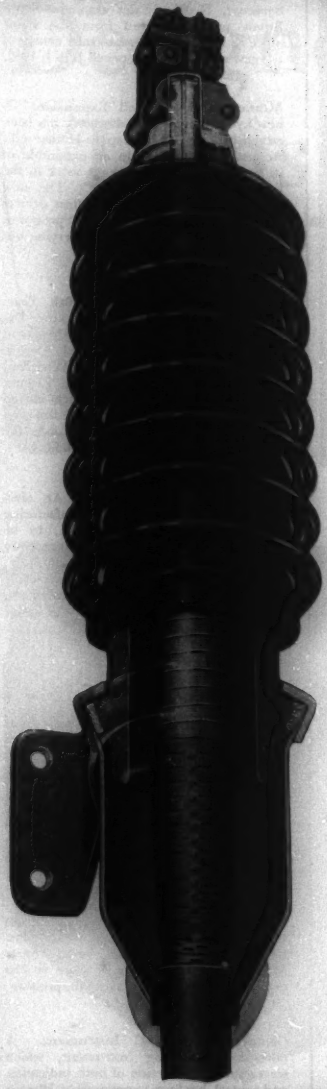
WAD 3963

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Offices & Plant: Marengo, Illinois

STRESS RELIEF CONES



improve the electrical characteristics of high voltage cable terminations

Stress relief cones reduce the unit electrical stress in the cable insulation at the end of the grounded sheath. They increase the overall internal dielectric strength and reliability of the cable termination.

Stress relief cones are recommended for all shielded cables and particularly for single conductor lead-covered and three-conductor shielded cables operating at 12 Kv. and higher voltages.

For compound-filled potheads on paper or varnished cambric insulated cables, a double cone is built up of half-lapped varnished cambric tape. The lower slope is wrapped with copper tinsel braid, tucked under the bell at end of lead sheath and soldered to the lead sheath and/or to the cable shielding tape. *On rubber insulated cables use Nozone rubber tape and TINNED copper tinsel braid.*

For gas and oil filled potheads, insulating tape is applied OVER the ordinary stress cone to compensate for the absence of solid compound and provide the necessary electrical strength.

Specify and order G & W POTHEADS with stress relief cone material in unit package kits. The correct amount of proper tape and shielding braid is supplied in convenient form — clean, dry and ready for use. Varnished cambric tape and coppper tinsel braid is oil packed in sealed cans.

G & W furnishes dimensions and instructions for stress relief cone installations, when requested on orders for potheads.

Send for Bulletin No. A52 which explains the theory of stress relief cones in potheads, and lists prices of unit kits for cables of various kinds and sizes.

G & W ELECTRIC SPECIALTY COMPANY

7780 DANTE AVENUE • CHICAGO 19, ILLINOIS, U.S.A.

Representatives in principal cities. In Canada, Powerlite Devices, Ltd., Toronto

BRUSH and the future of instrumentation

Brush Penmotor

FOR YEARS "Put it in writing" has been a favorite phrase of alert businessmen. Today the same idea is being effectively and economically applied to industrial and research instrumentation.

The Brush research and engineering staffs have applied "Put it in writing" to instrumentation by the development of the Brush Penmotor. This versatile device, the heart of a wide variety of Brush instruments, makes it possible to record at high speeds the variations of electrical currents, of vibrations, of strains, surface roughness, scores of other electrical and mechanical phenomena.

Because the Brush Penmotor records with an ink line, the line is uniform regardless of speed and the chart reading is permanent, instantaneously available. Ink recording paper is inexpensive, easy to load.

Brush engineers welcome the opportunity to discuss with you the application of recording oscillographs to your instrumentation needs so that you can put findings in writing. For further information, write The Brush Development Company, Department GE-9, 3405 Perkins Avenue, Cleveland 14, Ohio.

THE Brush DEVELOPMENT COMPANY

BRUSH

Piezoelectric Crystals and Ceramics
Magnetic Recording Equipment
Acoustic Devices
Ultrasonics
Industrial & Research Instruments

3405 Perkins Avenue • Cleveland 14, Ohio

(*Continued from page 76A*)

Tektronix Branch Office. Tektronix, Inc., has established a branch office in Syracuse, N. Y. Sales engineer Byron Broms was transferred from the home office in Portland, Oreg., to take charge of the new office. It was opened July 1, 1952.

Minneapolis-Honeywell Expansion. A new hydraulics testing laboratory has been established by Minneapolis-Honeywell's Aeronautical Division in an expansion of its research and development work in the field of hydraulic actuators. The new facilities, which include the latest devices for producing a wide range of test pressures, will be particularly useful in carrying out a miniaturization program.

Bulldog Electric Observes 50th Year. Bulldog Electric Products Company, Detroit, Mich., is celebrating its 50th year in the manufacture of industrial electric equipment. Established in Wheeling, W. Va., in 1902 as the Mutual Electric and Machine Corporation, the firm moved to Detroit in 1915. The company has been headed by William H. Frank since the death of his father, H. J. L. Frank, in 1939.

New Company Established. An electronics development and manufacturing organization in Baltimore, Md., to be known as Phebco, Inc., was set up recently by J. M. Pearce, P. A. Hoffman, and T. T. Eaton. It will specialize in electronic instrumentation, special test equipment, and telemetry for the missile and radar fields.

NEW PRODUCTS • •

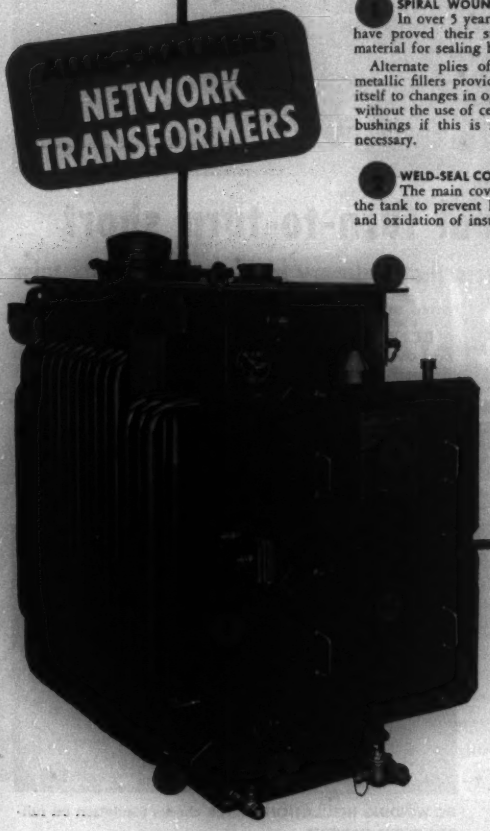
Air-Operated Valve. A pneumatically operated butterfly valve for control of air, water, or steam flow has been developed by the Industrial Division of Minneapolis-Honeywell Regulator Company. The pneumatic valve motor is described as a Grad-U-Motor power unit. It operates on a controlled air pressure range of 0 to 15 pounds per square inch. Adjustable mechanical stops provided on the motor enable the wing rotation to be limited for special applications. The valve is sized from $1^1/_2$ to 6 inches, with screwed connections. Body, wing, and trim material is bronze. Maximum operating temperature is 250 degrees Fahrenheit; maximum pressure, 20 pounds per square inch.

Contact-Making D-C Instrument. A new contact-making instrument, which serves the dual function of both indication and control, has been announced by Weston Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark, N. J. Known as model 1087, this specially designed switchboard instrument is of the new core magnet mechanism type. It has two adjustable stationary contacts, and a contact which is carried on the pointer. The low

(*Continued on page 32A*)

EVERY DETAIL

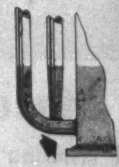
Designed to Extend Transformer Life!



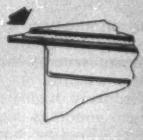
SPIRAL WOUND GASKETS ARE PERFORMANCE-PROVED. In over 5 years of continuous use, spiral wound gaskets have proved their superiority over other types of gasketing material for sealing bushings in the tank wall.

Alternate plies of preformed spring-like metal and non-metallic fillers provide unusual resilience that actually adjusts itself to changes in operating conditions. This gasket, installed without the use of cements or grease, simplifies the removal of bushings if this is required. The gasket may be re-used if necessary.

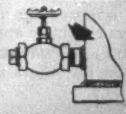
WELD-SEAL CONSTRUCTION ELIMINATES MAJOR GASKETS. The main cover and switch compartment are welded to the tank to prevent leaks and possible sludging. Oil sludging and oxidation of insulation is minimized.



SPECIAL SURFACE TREATMENT thoroughly protects areas that may be exposed to severe corrosive conditions. Tank surfaces are grit-cleaned and given three coats of baked-on phenolic paint (formulated for moisture resistance). A special bituminous compound gives added protection to surfaces and tubes in base areas.



THREADED VALVE CONNECTIONS are solder-wiped for extra protection. Valves are located to provide maximum accessibility. Globe type valves with nonrotating seats close tight, avoiding wear on valve seats.



EXCELLENCE IN CONSTRUCTION DETAIL goes a long way to help build wide product acceptance. That's just one of the reasons why Allis-Chalmers network transformers are fast-growing in preference and why over 1¼ million kva are now serving on the nation's important utility systems. Allis-Chalmers network transformers' compact, low-loss design and high thermal capacity meet the severest load conditions.

See your local A-C sales representative for more information or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3777

ALLIS-CHALMERS

Standing waves reveal turn-to-turn short

G-E Winding Insulation Testers find defects that ordinary high-potential tests miss

The photograph above shows the actual waves on the scope of a G-E Winding Insulation Tester. They indicate several short-circuited turns in a coil of a motor winding.

Ordinary high-potential tests, that only test between windings and ground, would not show this defect. Finding and correcting these hidden faults can improve the performance and lengthen the life of your electric apparatus.

10-kv AC WINDING INSULATION TESTER is designed to test for shorts in small and medium a-c windings rated up to 2000 hp., 2300 volts.

DC WINDING INSULATION TESTER applies up to and over 500 volts bar-to-bar for stressing insulation between coils and equalizer connections on low impedance d-c armatures. It can also stress insulation on large a-c stators.

Contact your nearest G-E Apparatus Sales Office for more information or write for bulletins GEC-321 and GEC-794 to General Electric Co., Sect. 687-104, Schenectady, N. Y.

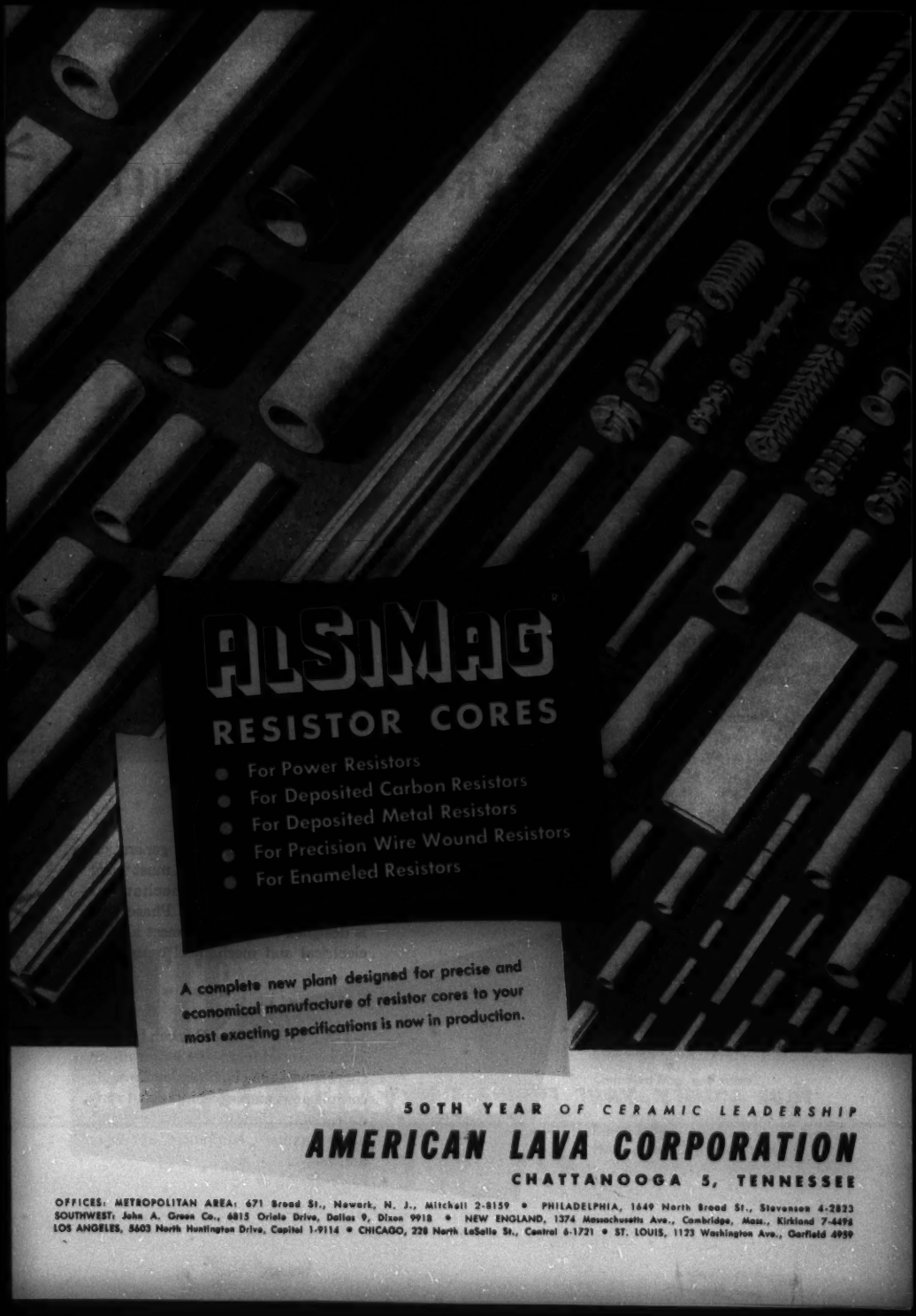
AC WINDING INSULATION TESTER in service shop tests rewound a-c motor stator.

DC WINDING INSULATION TESTER checks insulation on railway motor armature.

AC and DC Winding Insulation Testers

GENERAL ELECTRIC

Vol. 71
1952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RESISTOR CORES
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For Deposited Carbon Resistors
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For Enameled Resistors
A complete new plant designed for precise and economical manufacture of resistor cores to your most exacting specifications is now in production.
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CHATTANOOGA 5, TENNESSEE
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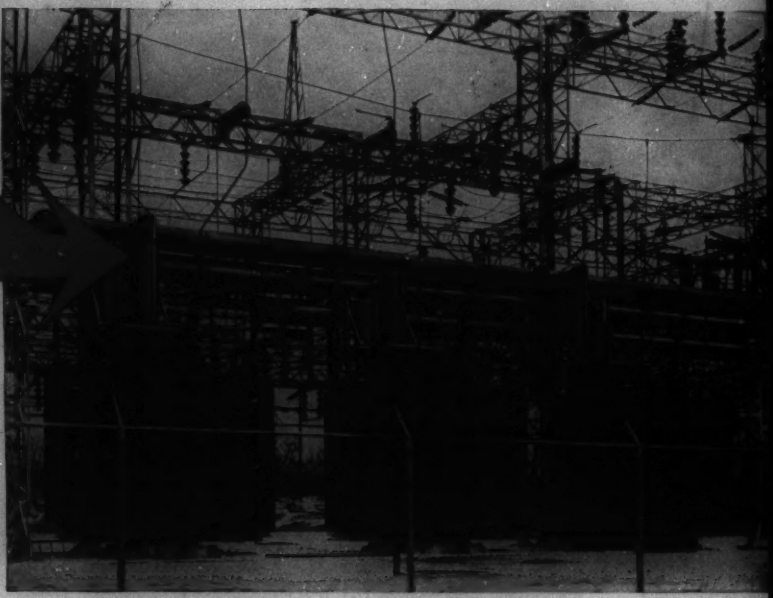
SOUTHWEST: John A. Green Co., 6815 Oriole Drive, Dallas 9, Dixon 9918 • NEW ENGLAND, 1374 Massachusetts Ave., Cambridge, Mass., Kirkland 7-4498
LOS ANGELES, 5603 North Huntington Drive, Capitol 1-9114 • CHICAGO, 226 North LaSalle St., Central 6-1721 • ST. LOUIS, 1123 Washington Ave., Garfield 4959

FIRST STEP
TOWARD SERVICE CONTINUITY...



Generator leads—

These key links in power generation and distribution systems must have high dielectric and mechanical strength. I-T-E Isolated Phase Bus is designed and built to meet all the electrical and mechanical essentials.

that satisfy your requirements

I-T-E Isolated Phase Bus can be used indoors or outdoors—on long runs or short runs. It can be threaded through complicated mazes of piping and conduit. Connections to transformers and other auxiliary equipment are neat and easy.

easy-to-order

Working from a simple, single line diagram of your circuit and building, I-T-E supplies finished drawings and a quotation for a complete bus.

And the bus production capacity of I-T-E and its R&IE Equipment Division is sufficient to satisfy the requirements of all the generators now being produced in the United States.

easy-to-install

Readily adaptable to any building contour, I-T-E Isolated Phase Bus may be furnished in sections of three phase units, when required. It may also be delivered as packaged parts—to meet particular installation problems.

proved in service

I-T-E Isolated Phase Bus has been transmitting the power from the largest generators since 1936. Over 24 conductor-miles in 213 installations are in service today.

For further information, write for Catalog Section 10004. I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pennsylvania.

I-T-E

ISOLATED PHASE BUS

Power Switching Equipment:
R&IE Equipment Division, Greensburg, Pa.

Canadian Mfg. and Sales:
Eastern Power Devices, Ltd., Toronto

Export Sales:
Philips Export Corp., N. Y., N. Y.

THIS IS AN INSULATING BARRIER

It is used to sectionalize a modern, totally-enclosed tubular bus, to serve as a "fire-wall" to prevent the running of fire, chimney-like, through the enclosed system.

From a ceramic production standpoint, this piece is "tricky" in the extreme. You see, in order to develop adequate flashover value—within a minimum diameter of housing, a projecting central flange is necessary. For electrical and mechanical security, the flange is integral with the main body of the bushing.

Without that flange, the piece would be a simple tube, of 7-inch inside diameter, with 1½-inch wall thickness. But the production of such a tube, with a wall thickness from which a piece like this can be formed, is quite another story. Only the most uniform of Vacuum-process clay body, formed, dried, turned and fired according to most advanced techniques, and under precision controls, makes its production possible.

These are the techniques, and the controls, of the Lapp production method. They account for the successful production of "nightmare designs" that "only Lapp could make." They account, too, for the superior performance of Lapp porcelain that spells "extra value" in any equipment with porcelain by Lapp. Look for the name LAPP on electrical equipment and insulators you buy. It's a guarantee of operating security, long life, low upkeep.

Lapp Insulator Co., Inc., Le Roy, N. Y.

Lapp

This Allis-Chalmers installation, both transformers and circuit breakers, is equipped throughout with O-B bushings. Every element of reliability was taken into account in this major switching station serving one of the South's heaviest load centers.

Illustrated in detail is a row of typical breakers whose characteristics are: "Rating, 600-1200 amperes, 69 kv, 1,500,000 kva interrupting capacity; frame-mounted, pneumatically-operated, three-pole, single-throw. All equipped with . . . . ."

BUSHINGS ONE OF THE FINEST COMPONENTS OF *ANY* CIRCUIT BREAKER

Ohio Brass

MANSFIELD · OHIO

4234-H

Precision

ATTENUATION to 3000 mc!

- VSWR less than 1.2 at all frequencies to 3000 mc.
- TURRET ATTENUATOR featuring "Pull - Turn - Push" action with 0, 10, 20, 30, 40, 50 DB steps.
- Accuracy ±.5 DB, no correction charts necessary.
- 50 ohm coaxial circuit. Type N Connectors.

Inquiries are invited concerning single pads and turrets having other characteristics

STODDART AIRCRAFT RADIO CO.
6644-B SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA
Hillside 9294

(*Continued from page 24A*)

and high stationary contacts, mounted on indexes, make or break under direct influence of the current in the instrument moving coil. Each index indicates the point of operation of its contact and can be independently adjusted over the entire scale range by means of an insulated knob on the front of the instrument. The contact circuit is electrically insulated from the moving coil circuit and is subjected to a dielectric test of 500 volts alternating current between these circuits, as well as between all circuits and the case. Contact rating is 6 volts 0.030 ampere direct current noninductive, maximum. Complete information can be secured from the manufacturer.

27-Inch Television Picture Tube. A 27-inch rectangular all-glass television picture tube has been developed by the Television Tube Division of Sylvania Electric Products, Inc. The 27-inch tube has neutral density gray-filter face plate to provide for glare reduction. It is a magnetically focused and deflected tube for use with an ion trap, and is supplied without an external conductive coating. By using a deflection angle of 90 degrees, the over-all length of the new tube is only 22½ inches, less than the length of smaller 21-inch tubes. The picture is approximately 18 inches high by 24 inches wide, providing about 400 square inches of picture area. The recommended operating conditions include anode—20,000 volts, grid #2—300 volts, ion trap field strength—45 gausses. Anode contact, base, and base connections are conventional.

Band-Pass Filter. Krohn-Hite Instrument Company, Cambridge, Mass., has developed a new band-pass filter, model 310-*A*. The model 310-*A* is an adjustable band-pass filter with unity pass again and 24 decibel/octave slopes outside the pass-band. A peaking factor is used to reduce the attenuation at the cutoff frequencies. Both the high and low cutoff frequencies are independently adjustable from 20 cycles per second to 200 kc. This provides maximum flexibility of adjustment of both the band-center frequency and the bandwidth. Further information is available from the Krohn-Hite Instrument Company, 580 Massachusetts Avenue, Cambridge, Mass.

Germanium Diode Checker. The General Electric Company has announced a germanium diode checker for use wherever a need exists for checking static characteristics of diodes. The new unit, type *ST-12-A*, has test clips for diodes having leads, and for those with pins on each end. Should test clips be short-circuited on any range, the circuit is designed to prevent instrument damage. Diode resistance is checked by placing a variable, accurately metered direct voltage across the diode. The resulting current appears on a second meter. The forward and inverse circuits are entirely separate. A diode may be checked to test limits in both the forward and back direction by moving a lever switch. A 3-inch voltmeter and 3-inch current meter

(*Continued on page 38A*)

Oil Immersed

SAFETY LINE DISCONNECT SWITCHES

30 - 60 - 100 - 200 - 400 - amp. available for 250 and 600 volt service.

Cutaway view (right) shows unique design of Rowan low-voltage AIR-SEAL fuse for use under oil.

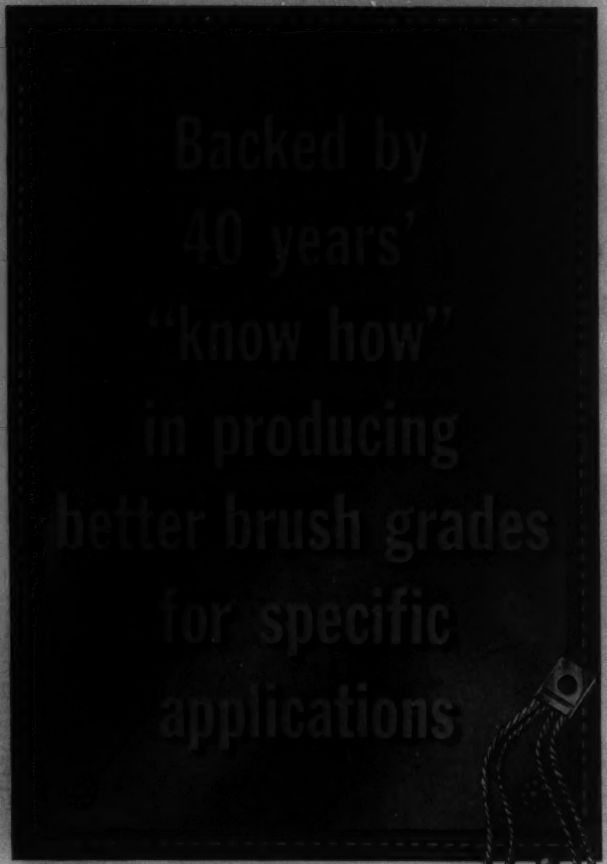
Rowan Type 620-A Line of Safety Disconnect Switches are designed to provide dependable service in all locations especially where the atmosphere is corrosive or charged with semi-hazardous dust or vapors such as chemical plants, oil refineries, steel, and cement mills. A few of the outstanding features of these switches include:

1. Completely oil immersed. 2. Equipped with Rowan time-tested AIR-SEAL fuses. 3. Disconnect switch of the quick-acting contactor type with renewable contacts. 4. Top and tank are mechanically interlocked with the disconnect switch to prevent lowering of tank when switch is in operating position or closing of switch when tank is lowered. 5. Provision for padlocking disconnect switch in the OFF position. 6. Enclosing case is weather resisting. 7. Unique arrangement for lowering tank for inspection without removing tank from unit.

Enclosures are NEMA Type XI: NEMA Type VIII enclosures are available. Complete information available from Rowan representatives in principal cities of the United States.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.



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for all rotating electrical equipment—from "flea power" to thousands of horsepower

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TROLLEY AND PANTOGRAPH SHOES . . . and dozens of carbon-graphite specialties

THREE NEW STANDARDS

STANDARD FOR SWITCHGEAR ASSEMBLIES AND METAL-ENCLOSED BUS (1-52)

AIEE Standard No. 27 (which supersedes No. 27 issued in 1942) covers assemblies of switchgear devices such as switches, interrupting devices, control, metering, protective and regulating equipment with associated interconnections, enclosed bus, and supporting structures.

$0.60; 50 per cent discount to members of the AIEE

AMERICAN STANDARD GRAPHICAL SYMBOLS FOR SINGLE (ONE) LINE ELECTRICAL ENGINEERING DIAGRAMS (9-51)

Sponsored by the AIEE, the American Society of Mechanical Engineers, and approved by the American Standards Association, Inc. This new standard, Y32.1.1-1951, contains graphical symbols for single (one) line electrical engineering diagrams. These diagrams indicate, by means of single lines and simplified symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein. It is intended that a single line diagram may be used to show essential components and functions in simplified form. Examples of diagrams and an index to graphical symbols are also included.

$1.40; 50 per cent discount to AIEE members

AMERICAN STANDARD FOR CAPACITOR UNITS (12-51)

AIEE Standard No. 18 and American Standards Association (ASA) No. C55.1 1951 supersedes the C55 issued in 1934. Sponsored by the AIEE and approved by the ASA, the standards in this section apply to shunt and series-connected capacitor units on a-c power transmission and distribution systems at nominal frequencies of 60 cycles or below, for the purpose of modifying the performance of the circuits at normal frequency.

$0.40; 50 per cent discount to AIEE members

The above new standards may be obtained from the Order Department, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, 33 West 39th Street, New York 18, N. Y.

9-52

Meet **MAC GORDAN** of Baltimore. He's our Purchasing Agent. His job is to locate suppliers who can produce materials and parts suitable for use in making Locke Insulators. He also sees to it that these suppliers come through with products which meet Locke's manufacturing standards. "You'd be surprised," remarked Mac, "how tough it is for us to find suppliers who produce materials and parts which come up to our 'specs'. It looks to me as if Locke has the highest, most rigid quality standards in the industry." We asked Mac to prove his point. He came up with three good examples. Here's the story, as he told it to us.

Here's why Mac Gordan pays premium prices for parts and materials used in making

LOCKE

Suspension Insulators

"Suppliers," says Mac, "simply can't meet our specifications with ordinary parts and materials."

"For example, take the case of our No. 1840 High Voltage Suspension, shown on this page. Our specification calls for forged steel ball bolts. These ball bolts must have ductility enough to neck-down before they break in a destructive pull test. They must also be capable of taking a 30° bend over a ⅛" radius in the neck area without breaking. This guarantees uniformly good tensile strength in the finished insulator. Suppliers had great difficulty meeting this unusual 'spec' with their generally accepted bolts. To give us the extra quality we demand, suppliers therefore charge us a premium price amounting to thousands of dollars extra a year. We absorb these extra costs, because we feel that our customers deserve this added assurance of trouble-free service."

On the next page Mac cites two more examples of Locke's use of premium parts in making insulators which give you premium performance ---

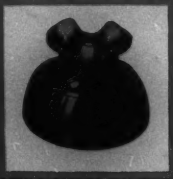
"The premium parts used in making our Suspensions are the best protection we can offer our customers," says Mac Gordan. "They want trouble-free service...we try to give it to them."

"A case in point," says Mac, "is this 6 inch dead-end. We had an opportunity to buy caps for this insulator for much less than we'd been paying. In checking, we found tiny cracks developing in the castings of these cheaper caps. We were told these shrink cracks were inevitable and wouldn't weaken the casting. But rather than lower our standards, and take a chance on quality, we decided to pass up this cheaper cap. We now use a premium-priced cap which costs us thousands of dollars a year extra. We absorb this cost because it gives customers the extra quality they expect in Locke 6-inch discs."

"Take this 25,000 pound Suspension," Mac continues. "Here's another case of 'what's good enough for others, often isn't good enough for us'. We wanted a new cap for this insulator. One supplier quoted a price 25 cents less than the usual price. Again, this cheaper cap was apparently well-accepted. In checking, we found lumps inside the casting, which though invisible, would tend to weaken the insulator assembly. What's more, the castings would not pass our gage for cotter key hole, roundness of lip diameter, and inside height and profile. The cap was obviously inferior. We're now paying 25 cents per insulator more than the average for this cap. This is just another good example of how we protect our customers at all times by using premium parts and materials."

YOU ARE EQUALLY SURE of getting a masterpiece of design when you specify other products in the complete line of Locke insulators and suspension hardware. Each pays off in superior performance on transmission and distribution lines, generating stations, sub-station and electrical apparatus. Locke Department, General Electric Company, Baltimore, Md.

LOCKE



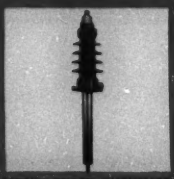
LOW VOLTAGE PIN TYPE INSULATORS

HIGH VOLTAGE PIN TYPE INSULATORS

SUSPENSION INSULATORS

SWITCH & BUS INSULATORS

SPOOL INSULATORS



LIQUID-FILLED BUSHINGS

SUSPENSION & STRAIN CLAMPS

SUSPENSION HARDWARE

ENTRANCE BUSHINGS

Another Westinghouse Relay Development

New CO Relay

gives greater accuracy!

The Type CO Overcurrent Relay is available in Flexitest or standard rectangular projection case.

This latest advance in design gives a degree of accuracy heretofore unattainable in an induction disc relay. The reason—a new basic relay development—the "E" element.

The "E" element has four separate and independent adjustments to make it meet existing time curves accurately—very accurately! This high degree of accuracy permits faster protection for your lines and equipment.

For further assurance of accuracy the new CO Relay offers low-wave form and low-temperature error . . . micrometer adjustment of the permanent magnet . . . constant "pick-up" at all lever settings.

Ask your Westinghouse representative to show you the new CO Relay—he'll be glad to go over it feature by feature with you—or request a demonstration by writing to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-40404

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S14-C OSCILLOGRAPH
is an essential in every laboratory
6 or 12 elements

For general laboratory use in industry and in colleges, for testing and research everywhere, the New S14-C Economy Oscillograph is doing the job.

This versatile high-quality oscillograph is opening up new and wide fields for oscillography because it is so easy to use and because its cost is so low. Attachments of many kinds are available for every possible need.

Many types of galvanometers are available for almost any sensitivity or frequency response requirement.

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9 record speeds, 1/10 to 40 inches per second
6-inch chart, sensitized paper or film
Smooth and positive chart drive
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Precision optical components
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INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

(*Continued from page 32A*)

permit voltage and current to be metered simultaneously. A chart of manufacturer's limits for about 40 of the most commonly used diodes is secured in the cover of the new unit. The *ST-72-A* is 10 inches high, 11 inches wide, and 6 inches deep. It weighs about 8 pounds. Further information is available from Department N-12, Inquiry Section, General Electric Advertising Division, Electronics Park, Syracuse, N. Y.

Portable Diesel Engine Pyrometer. The Bristol Company, Waterbury, Conn., has announced a portable diesel pyrometer designed for test purposes and for installations where no permanently mounted pyrometer is available. The thermocouples can be installed in each cylinder and in the main exhaust line. Temperatures can be checked then at any time by inserting the pyrometer prongs into the corresponding receptacles in the terminal head of the thermocouple. Full details are available from the manufacturer.

Solder Pot for Dip Soldering. Model 85, a solder pot for dip soldering large assemblies and printed circuit units, has been announced by the Dee Electric Company. The unit features high-efficiency and long-life ceramic embedded elements, with adjustable thermostatic control of temperature. Adjustable legs provide a convenient method of leveling the pot, and a detachable tray at one end serves as a receptacle into which dross is scraped. The inside dimensions of the pot are 12 inches long by 6 inches wide by $2^1/_8$ inches deep. Outside dimensions are $14^1/_2$ inches by 8 inches by 4 inches. The unit is for 110-volt alternating current and is rated at 900 watts. The temperature range is 450 to 700 degrees Fahrenheit. Further details may be had by addressing the manufacturer, Dee Electric Company, 1101 North Paulina Street, Chicago, Ill.

Motor Switch. Globe Industries, Inc., has announced the Globe motor switch, which is a combination of the "Moto-Mite" motor, a small concentric gear reduction, and a single-pole double-throw switch mechanism. The motor switch will interrupt an inductive high-current load to introduce a jizzle or activating signal in a control circuit, or any other circuit where high-speed switching action is desired. The motor switch features heavy-duty tungsten contacts, wiping action on contacts, and positive make and break of contracts. All switch and motor connections are located at the top on the terminal block.

Program Line Equalizer. The Daven Company of Newark, N. J., has announced the availability of its new type *286* program line equalizer consisting of a parallel network and calibrated-step-type series control, which is designed to improve the frequency response of communications circuits. The parallel network is tuned accu-

(*Continued on page 52A*)

Sources of
ELECTRIC ENERGY

Sources of Electric Energy (AIEE Special Publication S-42) comprises reprints of papers presented at three conferences on energy sources held at national general meetings of the AIEE and sponsored by the Basic Sciences Subcommittee on Energy Sources.

In order to provide information concerning aspects relating to the generation of electric energy which are not generally known to engineers, several papers included in this series deal with matters relating to animal electricity and with methods of generating electric energy which are unusual when compared with the conventional methods used in the power industry. Some of the latter methods make use of electrostatics, piezoelectricity, magnetostriction, and thermoelectricity.

Price: $1.50; $0.75 to AIEE members. Available from: Order Dept.,
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 West 39th Street
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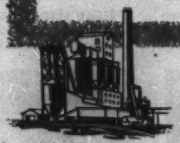
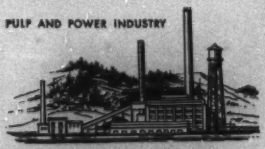
9-52

Industry looks to
RESEARCH CORPORATION
for high dust collection efficiencies



CHEMICAL PROCESS INDUSTRY

POWER PLANTS



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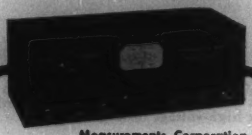

Measurements Corporation
MODEL 31

INTERMODULATION METER

- *Completely Self-Contained*
- *Direct Reading For Rapid, Accurate Measurements*

To insure peak performance from all audio systems; for correct adjustment and maintenance of AM and FM receivers and transmitters; checking linearity of film and disc recordings and reproductions; checking phonograph pickups and recording styli; adjusting bias in tape recordings, etc.

The generator section produces the mixed low and high frequency signal required for intermodulation testing. A direct-reading meter measures the input to the analyzer section and indicates the percentage of intermodulation.

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BOONTON NEW JERSEY

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THE ADVANCED single-lens reflex design of the 35-mm. PRAKTICA FX makes it easier for you to get expert photomicrographs, oscillographs, extreme close-ups, copy work, etc., in black and white or natural color. Use it for: Recording lab and field observations, quality control, inspections, photographing equipment in field, training personnel, etc. Excellent for the home photographer, too. From $99.50 to $199.50 (tax incl.).
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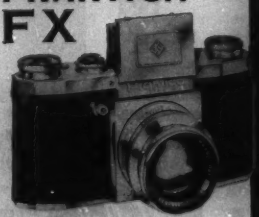

35-MM. SINGLE-LENS REFLEX CAMERA

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IN CONTROL BUILDING, engineers analyze test data on film two minutes after test. In background, with view of test area, operator at benchboard prepares to control next test.

SPECIAL TEST CARS quickly transport equipment prepared for test in assembly shop. When car rolls into test cell, equipment it carries is automatically connected in test circuit.

TEST CIRCUIT is set up on duplex control switchboard where bus diagram and indicating lights help engineers visualize entire test. Switchboard is easily seen from operating benchboard.

GIANT TESTING GENERATORS are used in conjunction with three step-down transformers for high-current testing, and with two step-up transformers for high-voltage testing.

A MOTOR DRIVEN, five-position tap selector switch automatically makes tap selection on high-voltage transformers located between the high-voltage test yard and the main test building.

11-ELEMENT MAGNETIC OSCILLOGRAPHS in control building and cathode ray oscillographs in test area record test data on films which can be analyzed two minutes after test is completed.

GENERAL ELECTRIC

GENERAL ELECTRIC'S NEW SWITCHGEAR DEVELOPMENT LABORATORY

New Multimillion-kva "Fact-finder" for Development of Tomorrow's Switchgear

Switchgear Development Laboratory has world's highest capacity testing facilities

American industry—now in the midst of its third and greatest expansion—depends more and more on dependable power equipment to help achieve present and future production goals.

To assure the best in proof-tested switchgear, General Electric has opened at Philadelphia this new switchgear development laboratory—a multimillion-kva "fact-finder" equipped to develop and test the switchgear needed for tomorrow's vastly increased industrial power load.

In two previous switchgear laboratories, General Electric has made over 300,000 tests which have played a large part in the development of modern switchgear. In this new development laboratory, General Electric has facilities for faster and higher-capacity tests than were ever before possible.

The new development laboratory is already at work proving the reliability of higher-capacity G-E switchgear that will handle rapidly increasing industrial loads and prevent power distribution failures and resulting work stoppages in your plant.

Because of the speed, accuracy, and increased number of tests possible, G-E's multimillion-kva "fact-finder" will make a great contribution to the design, development and testing of apparatus with higher voltage and interrupting capacity for the industrial loads of tomorrow. General Electric Co., Schenectady 5, N. Y.

854-50

Telephone Science Shares Its Knowledge

The Bell Telephone Laboratories Series of books is published by D. Van Nostrand Company. Other technical books by Laboratories authors have been published by John Wiley & Sons. Complete list of titles, authors and publishers may be obtained from Publication Dept., Bell Telephone Laboratories, New York 14.

List of Subjects: Speech and hearing, mathematics, transmission and switching circuits, networks and wave filters, quality control, transducers, servomechanisms, quartz crystals, capacitors, visible speech, earth conduction, radar, electron beams, microwaves, waveguides, traveling wave tubes, semiconductors, ferromagnetism.

In their work to improve your telephone service, Bell Laboratories make discoveries in many sciences. Much of this new knowledge is so basic that it contributes naturally to other fields. So Bell scientists and engineers publish their findings in professional magazines, and frequently they write books.

Most of these books are in the *Bell Telephone Laboratories Series*. Since the first volume was brought out in 1926, many of the books have become standards... classics in their fields. Twenty-eight have been published and several more are in the making. They embody the discoveries and experience of one of the world's great research institutions.

Bell scientists and engineers benefit greatly from the published findings of workers elsewhere; in return they make their own knowledge available to scientists and engineers all over the world.

BELL TELEPHONE LABORATORIES

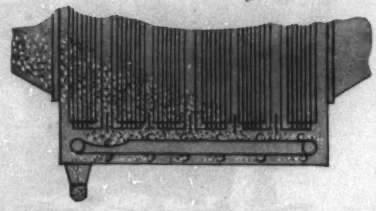
Improving telephone service for America provides challenging opportunities for individual achievement and recognition in scientific and technical fields.

Let's be practical about precipitators

1

This Koppers "packaged" mechanical or vacuum tube power pack is not restricted to an area near the precipitator. It can easily be installed in any convenient place in the plant. Result: Compact designs! More flexibility!

2



This Koppers exclusive—the bottom drag scraper—provides continuous dust removal. Cumbersome hoppers are eliminated and dust handling is simplified. Result: Lower operating costs! Less space requirement!

Here are two ways Koppers engineers simplify precipitator operation for you!

PERFORMANCE GUARANTEED!

Koppers engineers protect your investment in an electrostatic precipitator by guaranteeing both the recovery or gas-cleaning *efficiency* and the *residual content* left in the gas after cleaning. Koppers-Elex electrostatic precipitators are designed, engineered, fabricated, erected and guaranteed *under one contract* by Koppers Company, Inc.

IN ADDITION to high efficiency, Koppers concentrates on the practical aspects of electrostatic precipitator design. Shown above are just two of the many practical features which simplify operation.

Besides these compact power packs and the continuous dust removal features, Koppers-Elex electrostatic precipitators may be of the multiple-chamber type. This means one chamber may be shut down for inspection or maintenance without stopping the gas-cleaning action. The dirty gas is simply diverted through other chambers where cleaning continues.

Because rapping is *sectionalized*, re-entrainment is minimized. And because successive collection fields can be separately *energized*, maximum voltage can be applied to each field—with higher gas-cleaning efficiency resulting. Pressure drops are negligible.

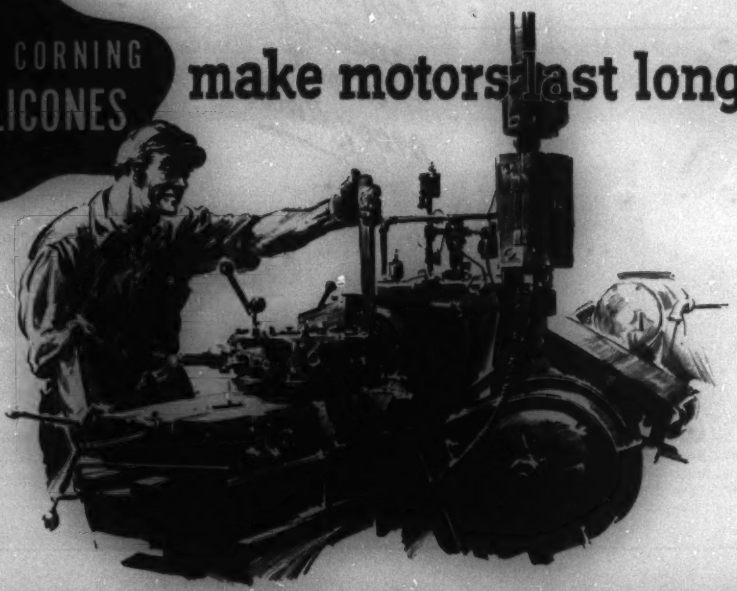
IF YOU HAVE A GAS-CLEANING PROBLEM, write and outline the details for us to review. There is no obligation. Just address your letter to: KOPPERS COMPANY, INC., *Precipitator Dept.*, 239 Scott Street, Baltimore 3, Maryland.

KOPPERS®

Koppers-Elex ELECTROSTATIC PRECIPITATORS

DOW CORNING SILICONES

make motors last longer



Failure rate on machine tool motors cut from 1 a month to 0 in 2 years!

In a line of 20 turret lathes, piece-work operators at Mueller, Ltd., Sarnia, Ontario, were burning-up drive motors at an average rate of one a month. These lathes were driven by Class B motors, rated at 5 hp at 650 rpm and subjected to 1200 full reversals an hour. Under such operating conditions, 18 replacement motors had to be carried in stock; occasionally all 18 of the spares were called upon to maintain production.

Two years ago, 25 of these motors were rewound with Silicone (Class H) insulation by Canadian Westinghouse Company. Twenty of them have been in service ever since. The 5 replacement motors are still standing by, in spite of the fact that some of the more ambitious operators took the overload capacity of these Class H motors as a personal challenge.

That kind of life and overload capacity, demonstrated in thousands of applications, proves the economy of Class H insulation made with Dow Corning silicones. Capable of putting out 50% more power than their name-plate rating, Class H insulated motors have 10 to 100 times the life expectancy of the next best class of motors under comparable service conditions.

Ask your motor supplier or rewind shop about Silicone (Class H) insulation or write direct to Dow Corning Corporation, Midland, Mich.

Keep Ball Bearings Properly Lubricated

In permanently sealed or cartridge type bearings, Dow Corning 44 Silicone grease makes permanent lubrication a practical reality. In many applications it outlasts the best organic lubricants 10 to 1 in either open or shielded bearings.

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Dow Corning Corp., Dept. H-21, Midland, Mich.
Please send me:
- ☐ Catalog of Class H Insulating Materials.
- ☐ List of Class H motor repair shops.
- ☐ Data on Silicone Grease for motor bearings.
- ☐ 32-page booklet entitled "What's A Silicone?"

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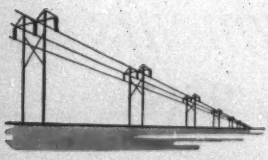
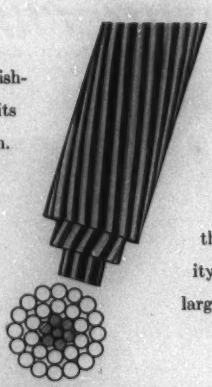
The Swedes know how to make conductors . . .

lighter*



One of the reasons why Feral Cable (Swedish-made ACSR) is in demand all over the world is its low weight combined with its great strength. The Swedish-made ACSR is 30% lighter and at the same time 30% stronger than copper cable. These factors also contribute to make the installation of Feral Cable cheaper. In round figures the saving in costs will amount to about 40%.



The Svenska Metallverken Feral Cable plant is being enlarged in order to make it possible to meet the enormous demand for ACSR today. At the turn of the year 1952–53 the capacity is estimated to equal that of the world's largest manufacturers of ACSR.

*FERAL ACSR cable

METALLVERKEN · SWEDEN

AB SVENSKA METALLVERKEN

SALES OFFICE: STOCKHOLM 16, SWEDEN

*Who benefits by 354 different Westinghouse Instruments to measure current?**

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The wide variety of Westinghouse Instruments helps you to realize primary design objectives—to make your product look better, perform better, sell better. For any application there's extra design freedom in the unusual diversity in size, types of mounting, accuracy and styling . . . the almost unlimited variety of ratings and style combinations. And the performance of all Westinghouse Instruments meets ASA Standards.

Production Chiefs

Proper instrumentation of production machines, processes or power supply can help you to attain more production, closer quality control or lower production costs. Whether your needs involve measurement of amperes, volts, watts, vars, power factor, frequency or synchronism, there's a Westinghouse Instrument for the job. The line also includes many types to measure position, time, temperature and speed. And Westinghouse Instrument Application Engineers are ready to assist you in applying them most effectively.

Vol. 71
1952

Purchasing Agents

In the full line of Westinghouse Instruments, you have a complete source of supply —one responsibility—for all of your electrical measurement needs. Moreover, Westinghouse offers you faster service because all designs are keyed to chassis stocking and assembly procedures.

Benefit this way!

Here's an example. A leading pipeline company, in a radical departure from conventional pipeline instrumentation, is using Westinghouse Electrical Measuring Instruments in pumping stations for pressure and flow indications at various points on the system. The result: More efficient control without fire hazard; greater accuracy; substantially less maintenance—a big, long-range saving! So if you design a product, produce it, or buy for it . . . specify Westinghouse Electrical Measuring Instruments!

J-40420

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The extensive coverage of Westinghouse current-measuring Instruments is further emphasized by the fact that there are 32 different instruments just to measure microamps.

For complete information about all Westinghouse Electrical Measuring Instruments, write for Booklet B-4696. Address: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

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Philco *Advanced Design* Microwave Systems are engineered for reliable, economical operation 24 hours a day, every day of the year. A signal level *1000 times greater* than normally needed gets your message through clear and strong, even under the most difficult conditions.

Philco's exclusive production techniques make it possible to produce equipment for the lowest possible cost consistent with high quality. Conservatively rated components insure reliable performance, economy of operation and minimum maintenance. The flexibility of Philco *Advanced Design* Microwave permits division of the broadband channel to carry up to 24 simultaneous 2-way telephone conversations . . . or further division for telegraph, teletype, telemetering, signaling or supervisory circuits. Future expansion can be easily accomplished with no loss of original investment.

Philco regional sales engineers are immediately available to discuss with you, in terms of *your* communications problem, the advantages and economy you may expect from Philco *Advanced Design* Microwave Systems.

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INDUSTRIAL DIVISION

PHILADELPHIA 34, PENNSYLVANIA

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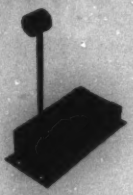
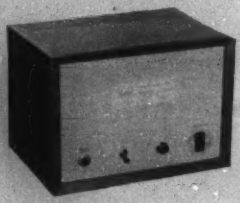


Thermistor bolometers are FAST, sensitive INFRARED and HEAT detectors. Especially RUGGED for industrial, scientific, and military applications. PREAMPLIFIER provides NOISE-FREE initial amplification and mount.



THERMISTOR POWER SUPPLY

Provides voltages required by BOLOMETER bridge and PREAMPLIFIER. Regulated and filtered permitting THEORETICAL NOISE LIMITS of amplification, while operating from 60 CYCLE line.

SERVO CORPORATION OF AMERICA

DEPT. EE-9 NEW HYDE PARK, N.Y.

MEASUREMENT of FIELD INTENSITY ABOVE 300 MC

from R-F Industrial, Scientific, and Medical Equipments

No. 950

This recommended practice gives information on methods of measurement, antenna design, and equipments used in making field intensity measurements after study of the problems resulting from the FCC rules relating to the operation of this type of equipment. Price: $0.80; 50 per cent discount to members of the AIEE.

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MINIMIZATION of INTERFERENCE from RADIO-FREQUENCY HEATING EQUIPMENT #951

This report on a recommended practice reviews the theoretical aspects of the interference problem and then outlines procedures which should be followed; which may be applied both in construction and as remedial measures where interference exceeds limits specified in FCC rules. Price: $.80; 50 per cent discount to AIEE members. Address:

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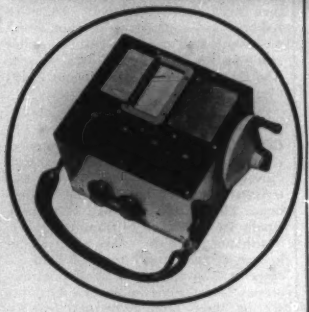
BIDDLE
Instrument News

- ELECTRICAL TESTING INSTRUMENTS
- SPEED MEASURING INSTRUMENTS
- LABORATORY & SCIENTIFIC EQUIPMENT

JAMES G. BIDDLE CO., 1316 ARCH ST., PHILADELPHIA 7, PA.



BRIDGE-MEG®

SAVES THE COST OF TWO INSTRUMENTS

SAVES TESTING TIME

The Bridge-Meg is really two instruments in one. It combines a Wheatstone Bridge for measuring conductor resistance of coils, resistors and circuits, and a Megger direct reading ohmmeter for measuring electrical insulation resistance. A Varley Loop feature for locating faults on wires may also be included. The combined, compact instrument weighs about 15 lbs.

Practically everything you need is provided in the Bridge-Meg for electrical resistance measurements from a fraction of an ohm up to 1000 megohms. A multi-position rotary switch changes internal connections between insulation resistance tests, Wheatstone Bridge and the Varley Loop connection. Scale reads directly in ohms and megohms.

The Bridge-Meg requires no batteries or outside source of current. Test current is supplied by a hand-cranked generator. Its constant-voltage mechanism eliminates the "human element" in the speed of turning the crank.

Available complete with carrying case and test record cards in a standard selection of 5 ohmmeter scales.

Write for 12-page **Bulletin 21-60-EE.**

FOR LOW RESISTANCE MEASUREMENTS 0 to 10,000 MICROHMS

Megger® Portable Low Resistance Ohmmeters

Self contained battery-operated and rectifier-operated types of Megger Low Resistance Ohmmeters have just been developed. They are designed for hard routine and emergency service in measuring contact resistance, such as in circuit breakers, relays, switches, bonds, connections and joints, commutator bar-to-bar tests and the like.

These portable instruments (weight 19 lbs.), are designed for low resistance measurements in the shop and in the field. They are of moderate cost and are accurate to within 1.5% of full scale deflection.

Model 1B operates from two 4 FH dry cells mounted inside the case.

Model 1R operates from a rectifier, built inside the instrument case, for connecting to 115 volts, 50-60 cycles.

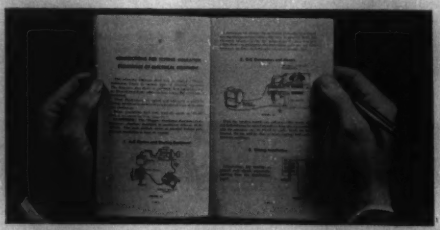
Both models have a range of from .001 to .010 ohms. These new instruments operate on the same crossed-coil ohmmeter principle as the Ducter Low-Resistance Ohmmeter, with pointer indications of resistance and no necessity for balancing or voltage adjustment. Scales have fairly uniform graduations and are approximately 3¼" long. Anyone can operate this equipment—no special training or experience is required.

(Model 1B—Battery Operated Set)

Write for **Bulletin 24-46-EE.**

MEGGER® MANUAL

tells you how to test ELECTRICAL INSULATION



This 94 page manual is in demand by educators as well as practical electrical men. It covers subjects of necessity to anyone who is responsible for electrical equipment.

"Why Test Insulation Resistance?"
"Preparation of Apparatus for Test"
"Tests When Drying Out Wet Apparatus"
"Temperature Correction"
"Methods and Interpretation"

These are but a few of the 14 chapters that are built around the subject of testing electrical insulation resistance . . . and, of course, effective use of the Megger® Electrical Insulation Resistance Tester sold in the U. S. only by the James G. Biddle Co. Supply is limited. Please write on your company letterhead for **INSTRUCTION MANUAL 21-J-EE.**

JAMES G. BIDDLE CO. B825
1316 Arch St., Philadelphia 7, Pa.

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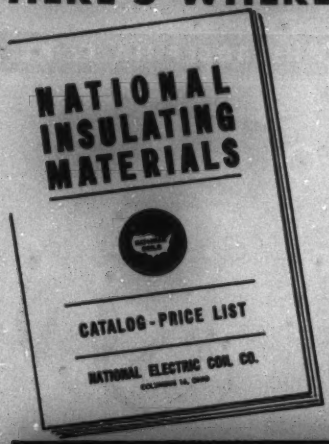
Need Insulation?
HERE'S WHERE TO FIND IT



If you use electrical insulation — a little or a lot — this pocket-size catalog-price list can be as handy as your right arm. It's free; write for it today. No searching through page after page for the item you want. Every item is carefully grouped with others of the same basic characteristics. Specifications and cost of every size or weight of every item are given. Every page is marked so clearly that you can't turn to it without knowing at a glance what's on it. First-page index lists every item, both alphabetically and by catalog number. It's really a time-saver. And when you order from it, you get quick action — you get *good insulation*. We can quickly supply special shapes and non-standard items, too.

NATIONAL ELECTRIC COIL COMPANY
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ELECTRICAL ENGINEERS MAKERS OF ELECTRICAL COILS AND INSULATION— REBUILDING AND REPACKING OF ROTATING ELECTRICAL MACHINES

3-pole, 400 ampere ASCO Feeder Control Switch with selenium rectifier mounted separately.

A companion line to our Bulletin 911 *Mechanically Held* Remote Control Switches, this new line of ASCO Feeder Control Switches is available in capacities ranging from 30 to 1000 amperes and for voltages up to 550 A-C and up to 250 volts D-C. All sizes are equipped with magnetic blowouts. Larger sizes are D-C coil operated for quiet operation. Suitable selenium rectifiers are furnished, mounted on the switch panel or on individual panel, as desired.

This latest development in the ASCO line of Switches (Bulletin 911-187S Series) is indicative of our service to industry in this particular division of electro-magnetic controls. Why not let us work with you on your electro-magnetic control requirements? That's what we're in business for. S-51-3a

ASCO Electro-Magnetic CONTROLS

Automatic Switch Co.
385-E LAKESIDE AVENUE • ORANGE, NEW JERSEY

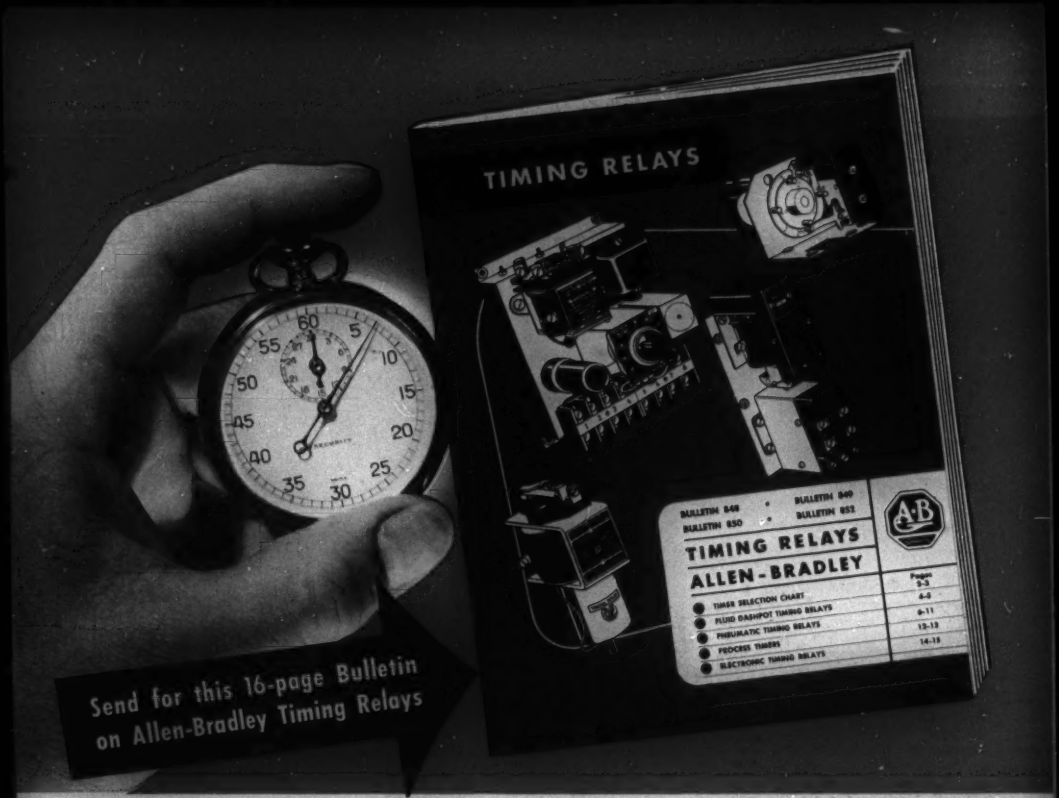
(*Continued from page 38A*)

rately to the frequency of equalization. The calibrated attenuator connected in series with this network controls the degree of equalization. Four points of equalization, 5, 7.5, 10, and 12.5 kc, are available readily by selecting the proper terminals. This unit has compact multichannel assemblies consisting of 1, 2, 3, or 4 equalizers and associated frequency selection switches mounted on a standard 5¼-inch by 19-inch relay rack-type panel. These assemblies are equipped with dust cover, terminal blocks, and are wired completely ready for use. For further data, write to The Daven Company, Department P, 191 Central Avenue, Newark, N. J.

CO Relay. The new type *CO* protective relay, a slow-speed overcurrent type with "inverse" or "very inverse" time characteristics, is available now from the Westinghouse Electric Corporation. Used principally for protection of transmission and distribution lines, the relays are available in one of the three ranges—0.5 to 2.5 amperes, 2 to 6 amperes, or 4 to 12 amperes. Accuracy, flexibility, and reliability are its three most important features. Accurate timing is provided by adjustable magnetic plugs in the newly designed "E" element electromagnet. Accurate pickup at tap value of current for all disk positions is provided by two independent adjustments. Accurate adjustment of the damping torque of the permanent magnet can be made by means of a keeper screw without moving the magnet. Since the relay can be changed in the field from one time characteristic to the other, it has considerable flexibility. It is mechanically and electrically interchangeable with the old type of *CO* relay. Metal-to-metal contact between tap terminal and tap plate, as provided by the positive action tap block with "self-positioning" taps, make the contact system of the new relay reliable. The 1-piece die-cast frame and the cast alnico magnet add to its reliability, and the nongeared design reduces maintenance needs. For further information, write the Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.

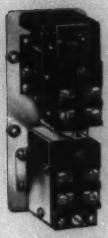
Differential-Voltage Indicator. A new indicator, designed to measure differential voltage, as well as amperage, speed, pressure, and other quantities which can be converted to voltage, has been announced by the Meter and Instrument Department of the General Electric Company. The new device, basically a high-resistance precision voltmeter containing an electronic amplifier, features a self-balancing circuit which possesses a high degree of stability and freedom from drift. It is capable of measuring a 0.001- to 30-volt differential of two input voltages ranging from 1 to 400 volts, provided they do not differ by more than 300 to 1. The instrument can be set to indicate full scale for voltages as small as 0.022 volt. The scale can be marked in volts, amperes, feet per minute, and so forth. The General Electric Company, Schenectady, N. Y., will furnish full details.

(*Continued on page 56A*)



FOUR POPULAR TIMERS • SIMPLE AND DEPENDABLE

PNEUMATIC

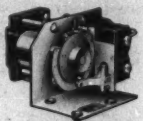


Bulletin 849 pneumatic timing relay is a long life timer of high repetitive accuracy. Has an adjustable pneumatic bellows for regulating the tripping time. Time delay minimum—⅛ second; maximum—3 minutes. The operation of this pneumatic timer is easily changed from "on delay" to "off delay." A reliable, compact timer that is available in a wide variety of contact arrangements. It can be furnished in open type or in enclosures of various constructions.

FLUID DASHPOT

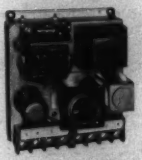
Bulletin 848 fluid dashpot timing relay is a low cost, adjustable timer for applications not requiring a high degree of accuracy, such as for timing electrically operated valves, motor starting sequences, etc. Time delay minimum—2 seconds; maximum—30 seconds. Single pole contacts, either normally open or normally closed. Silicone dashpot fluid assures consistent action at low ambient temperatures. Furnished in open type for panel mounting, or in pressed steel and cast iron enclosures for every service.

MOTOR DRIVEN



Bulletin 850 Style L motor driven timer is a precision switch of the maintained contact type. It alternately opens and closes two switch units 2, 3, 4, or 6 reversals per min. Ideal for controlling reversible machinery such as laundry washers or other processing equipment. Run and drift time easily adjusted. Silver alloy contacts.

ELECTRONIC



Bulletin 852 Electronic Timer has a thyratron tube used as a combination a-c rectifier and electronic switch. In 8 timing ranges from 0.025 sec. to 2 min. Accuracy 2% of setting. Ideal for machine tools, high frequency heating equipment, and photographic printing.

STANDARD ENCLOSURES FOR EVERY SERVICE

NEMA Type 1

NEMA Type 4

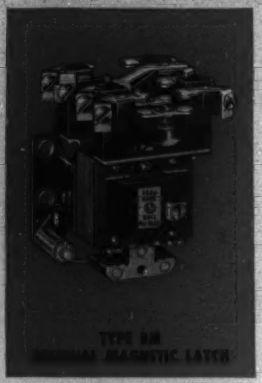
NEMA Type 7

ALLEN-BRADLEY
QUALITY
TIMING RELAYS

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

6-52—MR

HUM-FREE A-C RELAYS

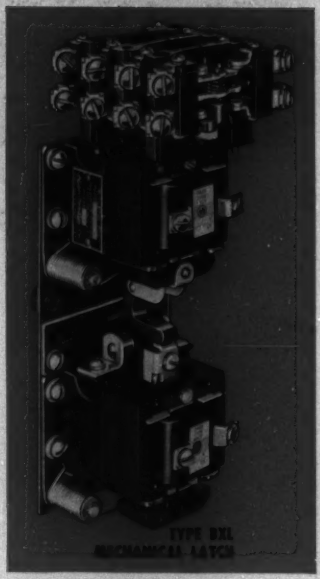


Here are two unique, hum-free relays that require no coil current to keep them closed.

The Type BM relay is a compact unit which is closed by momentarily energizing the solenoid coil. The relay is held firmly closed by residual magnetism until opened by a momentary demagnetizing current.

The Type BXL relay is a standard Bulletin 700 magnetic relay with a mechanical latch. The secondary solenoid, beneath the relay, delatches the upper relay to open it.

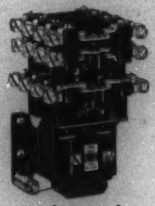
Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wis.



A-C and D-C TROUBLE FREE CONTACTORS and RELAYS
for Automatic and Sequence Controls

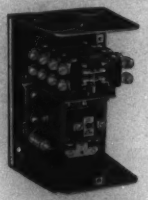
4 Pole A-C Relay

This universal type relay is equipped with four normally open contacts and four normally closed contacts, all actuated by one solenoid plunger. Great flexibility of circuit connections is offered by the double arrangement of contacts. Will handle circuits up to 600 volts a.c. Widely used in refrigeration and air conditioning. Contacts need no maintenance.



8 Pole A-C Relay

Bulletin 700 relays are listed in many contact combinations and polar arrangements. They are widely used for oil burners, stokers, unit heaters, and as control relays for electric furnaces. They are good for millions of trouble free operations. Their consistent performance makes them ideal for machine tool sequence operations. There is no contact maintenance.

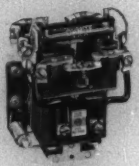


Relay in Enclosure

These relays can be furnished open or in enclosures that protect them in applications where watertight, weatherproof, or explosion-proof enclosures are needed.

Push buttons and limit switches available in a variety of enclosures.

Send for Allen-Bradley Bulletin 700 for details of relays with 1, 2, 3, 4, 5, 6, 8, and 10 poles.



3-Wire Thermostat Relay

Low Current A-C Relay

For temperature controls with thermostats.

D-C Relay

2 N.C.—1 N.O. contacts.

A-C Contactor

Allen-Bradley a-c contactors are available up to 900 amperes.

D-C Contactor

Allen-Bradley direct current contactors are available in single and double pole construction up to 600 amperes.

ALLEN-BRADLEY

RELAYS & CONTACTORS

6-52—R

INSTRUMENTS

PRODUCTION TESTING

REDUCE TEST TIME WITH THESE 3 G-E INSTRUMENTS

Yale & Towne Cuts Testing 10% By Using G-E Hand Tachometer

"Besides cutting our testing time by 10%, the new G-E hand tachometer has proved to be the only speed-measuring instrument which we have that will give an accurate and instantaneous reading," reports Yale and Towne, manufacturers of materials-handling equipment.

HIGH ACCURACY

Employing a unique electrical-reactance principle, the hand tachometer has a high accuracy of ±1% under all conditions. It is designed for long life and low maintenance. Because the hand tachometer consists of two parts—the indicating unit and a head connected to the indicator by a flexible cable—it is easy to make measurement in normally inaccessible places. The indicator can always be held in easy-reading position while the small head is held against the rotating part.

LOW COST

Measuring ranges for rotational speeds are from 100–10,000 rpm in three ranges, and linear speeds from 20–10,000 fpm in six ranges. High and low-speed adapters are available extending the range from 10–100,000 rpm. Price, complete with case and accessories is $118.01*.

Vibration Recorder Prevents Costly Machinery Breakdowns

According to a large New England manufacturer, the G-E portable recording vibrometer helps protect them from costly, emergency shutdowns of their punch presses. By analyzing the permanent record of machine vibration provided by the vibrometer, their engineers are able to determine what preventative maintenance is necessary before serious damage is done.

The recording vibrometer measures and records frequency, displacement, and waveshape of mechanical vibration. Both steady-state and transient vibrations are thus obtained and the record is

available for future study and comparison. Common applications include vibration checks of bearings, shafts, gear trains, and etc.

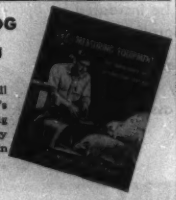
WIDE RANGE

The G-E vibration recorder will measure frequencies ranging from 10 to 120 cps having amplitudes from 5 to 125 mils with 0 to 20 G acceleration. It is accurate to within 5 per cent. Price is $432.12*

1952 CATALOG

G-E Measuring Equipment

80 pages describing all of General Electric's testing and measuring devices. For free copy check GEC-1016 in coupon at right.



Measure Vibration Easily with G-E Light-Beam Vibrometer

Indispensable for vibration testing of reciprocating or rotating equipment is the G-E light-beam vibrometer. Easy to use, this vibrometer indicates immediately points of excessive vibration in machinery or buildings.

The photograph above shows the portable lightbeam vibrometer being used to check the vibration at the critical speed of a motor being tested in a large eastern electrical manufacturing plant.

RANGE

The vibrometer is available with either of two scales: 0–15 or 0–30 mils. It is accurate to within 3% of full scale and is responsive to frequencies of from 15 to 250 cycles per second. Price is $233.22.*

* Mfg. suggested retail price.

SECTION A605-24, GENERAL ELECTRIC
SCHENECTADY 5, N. Y.

Please send me the following bulletins:
Indicate:
√ for reference only
× for planning an immediate project

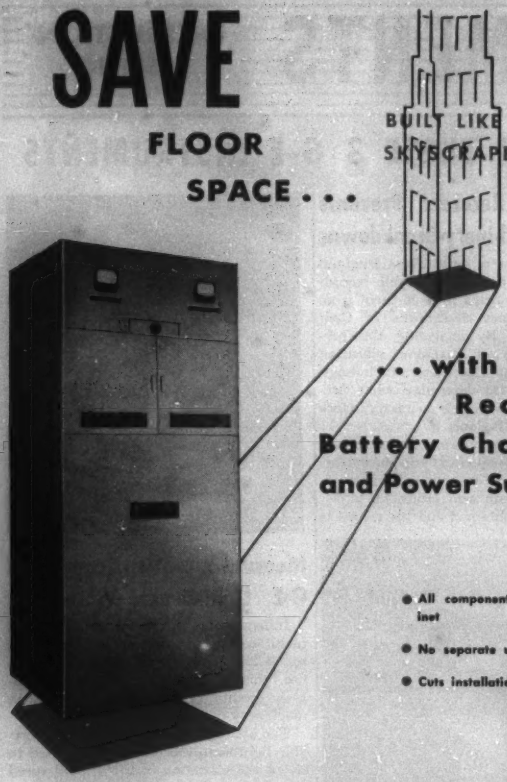
- ☐ Hand Tachometer GEC-241
- ☐ Vibration-Measuring Equipment GEC-853
- ☐ 1952 Catalog GEC-1016

NAME.....
COMPANY.....
STREET.....
CITY..... ZONE..... STATE.....

GENERAL ELECTRIC

SAVE

FLOOR SPACE . . .



. . . with PECO Rectifier Battery Chargers and Power Supplies

- All components in one cabinet
- No separate units to install
- Cuts installation costs

INCREASED building costs make the saving of floor space an extremely important factor in any plant today.

That is why PECO rectifier battery chargers and power supplies are built on the "skyscraper" principle to best utilize valuable floor space. For example, the battery charger illustrated here occupies less than 1 sq. ft. per KW, and no special foundations are necessary. Capacities can be increased by operation of two or more units in parallel.

With the many years of experience in the development and manufacture of closely regulated rectifiers of all types, PECO is ready to assist you with your next rectifier application.

POWER EQUIPMENT *Company*

55 ANTOINETTE STREET / DETROIT 2, MICHIGAN

(Continued from page 52A)

Oscillograph. An oscillograph which will record under extreme shock and acceleration conditions, model 560, has been developed by Midwestern Geophysical Laboratory, Tulsa, Okla. The instrument is capable of making 12 simultaneous records, although the width (less mounting flanges) is only $4^3/_8$ inches. Its height is 5 inches and length is 7 inches. Weight is $8^1/_4$ pounds (less film). Recording film width is $3^1/_2$ inches; length, 40 feet. Other features of the oscillograph include cast aluminum case and magazine with mounting flanges cast integral with case; choice of three film speeds (by gear change, gears included); 12-channel magnetic assembly with facilities for mounting damping resistors for each channel inside oscillograph; all operating controls and viewing screen accessible from one end; large variety of galvanometers available for use; undamped natural frequencies up to 3,500 cycles per second.

Transformer and Yoke for Television Receiver Conversion. A special Converkit containing RCA Victor's first universal horizontal-deflection-output and high-voltage transformer and a ferrite-core deflecting yoke, designed for converting small-screen television receivers to use kinescopes up to 21 inches in size, has been announced by the company's Tube Department. Heart of the Converkit is the special RCA universal horizontal-deflection-output and high-voltage transformer, which is designed for replacement use in television receivers utilizing transformers which have isolated secondary windings, or for general conversion service. This transformer covers a high-voltage range of 10 to 15 kv. Numerous secondary-winding taps are provided on the transformer to facilitate the securing of an accurate match between the driver tube and any yoke having a horizontal-coil inductance from 8 to 30 millihenries. This multitap arrangement permits the use of the transformer with a wide range of kinescopes having horizontal deflection angles from 50 to 66 degrees. The transformer's primary winding is tapped to take care of "B" supply voltages from 250 to 300 volts and accommodate all standard driver tubes. The anastigmatic deflecting yoke features a ferrite core for high-deflection sensitivity, distributed windings of a modified cosine design for sharp corner focus, and negligible pattern distortion. It is supplied complete with 12-inch leads, two vertical damping resistors, and a neutralizing network for the horizontal coils.

TRADE LITERATURE

Distribution Apparatus Digest. A 100-page catalogue, the Distribution Apparatus Digest for 1952, is available from the Westinghouse Electric Corporation. Preceding the catalogue section are conversion tables and formulas, approximate discounts, a Quick-Finder index, and a discussion of standardized substations for distribution

(Continued on page 64A)

FINEST DISTRIBUTION PINTYPES EVER MADE

THANKS TO VICTOR PURIFIED PORCELAIN!

There are many reasons why power men are partial to Victor Pintype insulators . . . but the biggest is that they're made of VICTOR *PURIFIED* PORCELAIN—finest insulator porcelain ever made! *PURIFIED* PORCELAIN gives these pintypes a strength and resistance to impact that are unequalled. Puncture values are higher. Uniformity, hardness, density and durability are greater than ever before!

AND, remember, every Victor Pintype is electrically tested before shipment. *The result*—dependability under *all* service conditions!

VICTOR INSULATORS, INC., VICTOR, N. Y.

VICTOR NO. 5
DISTRIBUTION PINTYPE

ADVANCE DESIGN FOR ALUMINUM CONDUCTORS

For the larger aluminum conductors being used today, Victor has increased wire groove sizes on distribution pintypes. For complete engineering data, write today for Bulletin No. 4.

Specify VICTOR PINTYPE INSULATORS

Two Piece TRANSFORMER INSULATOR

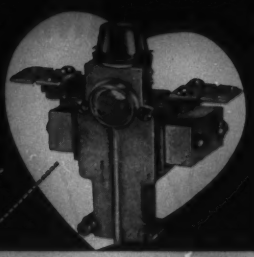
For use in Neon Sign Transformers, one piece fits inside transformer case, other piece fits outside case, forming a perfect insulator.

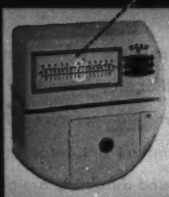
• Porcelain insulators, properly engineered and applied, add high dielectric and physical strength. In Universal Porcelain insulators, you gain this extra protection . . . plus higher resistance to temperature changes, moisture, fumes and most acids. On your next insulator job, specify Universal Porcelain.

THE UNIVERSAL CLAY PRODUCTS CO.
1560 EAST FIRST STREET SANDUSKY, OHIO
TRADE MARK

Make a GM PORTABLE D'ARSONVAL GALVANOMETER

the Heart of Your Instrument

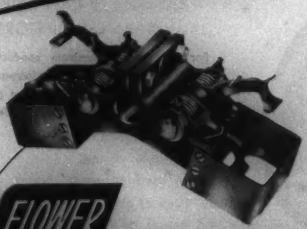




IN THE AUTOMOTIVE FIELD, the Bear Manufacturing Co. of Rock Island, Ill. uses Series 500 G-M Galvanometers in its new remote-reading Electric Wheel Alignment System (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

GM LABORATORIES • INC.
4338 NORTH KNOX AVENUE, CHICAGO 41
In Canada: Cossor (Canada) Ltd., 301 Windsor Street, Halifax, N. S

Important!



FLOWER ELECTRIC BRUSH HOLDERS ARE JOB-DESIGNED

• Here is a double tandem brush holder specially designed for The Yoder Company's 4400 KVA welder—a typical example of Flower job-design and production. Discover how Flower brush holders save maintenance time and money. Get the facts!

WRITE
For Catalog 4E

FLOWER ESTABLISHED 1909

1217 SPRING GARDEN ST. PHILA. 23, PA.

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Prompt notification of a change in address accomplishes three things simultaneously: change of address in the AIEE national records; change of mailing address for ELECTRICAL ENGINEERING; and notice to the local section to change the section mailing list. Therefore, if you have an address change, fill out the form below and mail it promptly to: AIEE Headquarters, 33 West 39th Street, New York 18, N.Y.

Name.....

New Street Address.....

City..... (Zone No.) ....State.....

Former Mailing Address.....

Membership No..... (as shown in your mailing address)

To assure a correct entry in the YEAR BOOK of the AIEE, please also furnish:

Company Name.....

Company Address.....

Department.....

Title (if one has been assigned) .....

Home Address.....

Are you a registered Professional Engineer?.....

9-52

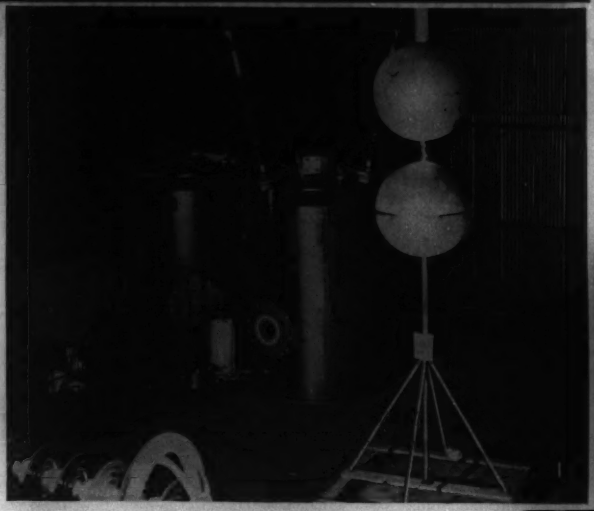
x = Manufacturer's Tests

$f(x, y, z)$ = Protective Performance

PACIFIC ELECTRIC

OIL CIRCUIT BREAKERS

embody the "X" factor to a high degree



PACIFIC'S TEST PROGRAM IN ACTION

is partially shown by these views

1. Pole Unit of 161-kv, 10,000,000 kva, Type RHE withstands 365 rms kv, 60-cycle.
2. Pole Unit of 230-kv Type RHE withstands 445 rms kv, 60-cycle, under water spray of wet test.
3. An at-site setup for field test of interrupting rating, using two units at 230 kv. Interruptions to 9,600,000 kva (ASA) at 240 kv were obtained—the maximum from the generating facilities available.
4. High-speed camera, making 3000 pictures per sec, records motion of latch linkage during design studies.
5. Impulse Generator used for crest voltage tests to two-million volts (1.5 x 40-ms wave).

CIRCUIT BREAKER Performance is a function of several factors, of which the manufacturer's test program is but one. However, this "x-factor," as some call it, deserves as much attention when selecting circuit breakers as does any of the tangibles.

Pacific Electric's facilities and arrangements for testing, and their use by trained test personnel, have contributed significantly to the reputation that Pacific breakers enjoy among today's application engineers.

Design tests cover such matters as insulation withstand (60-cycle and impulse), interrupting time and current, momentary and 4-sec high currents, the continuous-current heat run, and check of mechanical features (the 5000-operation design test).

Noteworthy is Pacific's policy of field testing at locations where maximum interrupting current may be obtained at full voltage and high recovery rates. Seven such field test programs have been completed during the last five years; they avoid need of extrapolating from laboratory tests in which one or more of the elements may be missing.

Since 1906

SALES OFFICES or AGENCIES in PRINCIPAL CITIES

PACIFIC ELECTRIC MFG. CORPORATION

5815 THIRD STREET, SAN FRANCISCO 24, CALIFORNIA • 4500 HARRISON STREET, GARY 10, INDIANA

You'll find more Career Opportunities at RCA

UNUSUAL career-building openings await experienced

ELECTRONIC ENGINEERS . . .
ELECTRICAL ENGINEERS . . .
MECHANICAL ENGINEERS . . .
COMMUNICATION ENGINEERS . . .
COMPUTER ENGINEERS . . .
PHYSICISTS . . .
and METALLURGISTS

Positions open offer lifelong career opportunities to men who expect more from their work than is provided by an ordinary engineering assignment.

RCA IS A GOOD PLACE TO WORK

At RCA you receive recognition for your accomplishments. You work in close collaboration with distinguished scientists and engineers. You enjoy highest professional recognition among your colleagues. You have unexcelled facilities for creative work. The surroundings in which you work are pleasant and stimulating. You and your family enjoy outstanding employee benefits. Opportunities are excellent for advancement in position and income. Unlike "feast-or-famine" businesses, RCA has forged ahead regardless of war or depression.

Immediate Openings in
RESEARCH · DEVELOPMENT · DESIGN · APPLICATION
in the following fields:

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COMMUNICATIONS · TECHNICAL SALES
ELECTRONIC EQUIPMENT FIELD SERVICE

Send a complete résumé of your education and experience.
Personal interviews arranged in your city.

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RADIO CORPORATION of AMERICA

PARKWAY CABLE

Save the cost of duct systems!...with the most dependable Parkway Cable you can buy!

ROEBLING'S research staff is continually working at the job of product development. Our manufacturing facilities and techniques are constantly improved. That's why our Parkway Cable for distribution and general power supply circuits is today even more dependable than ever before.

Roebling Parkway Cable saves money right from the start because it is buried directly in a shallow, low-cost trench. It is made in single and multiple conductor – solid or stranded – in a range from 600 to 5,000 volts . . . furnished with metallic armor or a non-metallic *Roeprene* sheath, depending on the physical protection required. Types that pass all C.A.A. requirements for Specification No. L-824 for airport lighting are also available.

Large quantities of Roebling's full line of electrical wires and cables are needed in the rearmament program. We and our distributors will do everything possible, however, to meet your requirements. John A. Roebling's Sons Company, Trenton 2, N. J.

ROEBLING

ATLANTA, 954 AVON AVE • BOSTON, 81 SLEEPER ST & 5 PITTSBURGH ST • CHICAGO, 5525 W. ROOSEVELT RD • CINCINNATI, 3253 FREDONIA AVE • CLEVELAND, 701 ST. CLAIR AVE, N. E. • DENVER, 4801 JACKSON ST • DETROIT, 915 FISHER BLDG • HOUSTON, 6216 NAVIGATION BLVD • LOS ANGELES, 5340 E. HARBOR ST & 120 S. HEWITT ST • NEW YORK, 19 RECTOR ST • ODESSA, TEXAS, 1930 E. 2ND ST • PHILADELPHIA, 230 VINE ST • PITTSBURGH 1201 CLARK BLDG • ROCHESTER, 1 FLINT ST • SAN FRANCISCO, 1740 17TH ST • SEATTLE, 900 1ST AVE S. • ST. LOUIS, 3001 DELMAR BLVD • TULSA, 321 N. CHEYENNE ST • EXPORT SALES OFFICE, TRENTON 2, NEW JERSEY

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INDUSTRIAL GRADE LAMINATES

NEVAMAR industrial grade laminates simplify problems for designers and fabricators of parts and products. Produced in a number of different grades to meet varying requirements, NEVAMAR meets or exceeds the exacting standards established by the National Electrical Manufacturers' Association. Its superior properties make NEVAMAR suitable for numerous mechanical and electrical applications. Learn for yourself how NEVAMAR measures up to your requirements. We'll gladly send you samples.

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AIEE REPORTS

These publications are proposals for new standards or test codes, or revisions of present publications, which are in the formative stage. They are made available, *without cost*, so that all interested individuals may obtain them for study and comment, thereby supplying practical experience in their use before submission for adoption.

16A Electric Control Apparatus for Land Transportation Vehicles (April 1951)

24 Protector Tubes (July 1940)

28A Valve and Expulsion Type Lightning Arresters (February 1950)

50 Automatic Circuit Reclosers for A-C Distribution Systems (September 1949)

51 Guiding Principles for Dielectric Tests (September 1949)

52 Application Guide for Grounding of Instrument Transformer Secondary Circuits and Cases (March 1951)

502 Test Code for Single-Phase Motors (November 1941)

800 Test Code for Direct-Current Aircraft Machines (March 1947)

801 Test Code for Aircraft Interrupting Devices (August 1950)

American Institute of Electrical Engineers — 33 W. 39th St., New York 18

9-52

Try the new ultra high-speed Skil Grinder if you want to see—and *feel*—something new in grinder performance. Packs twice the power per pound of any other grinder . . . tool and die makers say it's the best they've ever used!

90,000 MILES... without a breakdown!

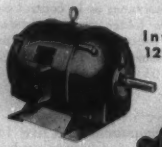
An example of Robbins & Myers Motor Engineering that will interest the executive with motors in his product

Skilsaw, Inc., wanted the best for the brand-new 1" Skil Grinder you see above. The motor, for example, had to be lightweight, compact, powerful—and capable of running for long periods at 36,000 RPM! As they have for the past 25 years, Skilsaw gave Robbins & Myers the motor space limitations . . . told us to take it from there.

600 revolutions per second is going some! To withstand the high centrifugal force built up, we designed a special motor, dynamically balanced, with a diamond-turned commutator and special windings that would *stay* in place. Result? During a test which has run 881 hours to date, the armature has traveled about *90,000 miles at 102 m.p.h.* without a single breakdown! And to top it off, this Skil Grinder *has twice as much power* as other grinders of similar weight.

Power Tools—for that matter, all motor-driven products—are as good as their *power source*. Leading manufacturers of such equipment rely on R & M for the best in motors. We've spent years accumulating engineering skills, while producing millions of complete motors and matched motor parts. If one of the many standard R & M motors doesn't solve your problem, we have the ability, as demonstrated above, to custom-design motors or motor parts that will meet your *exact* requirements . . . *quickly and economically*.

CUSTOM-DESIGNED OR STANDARD . . .
There's an R & M motor that will meet your *exact* requirements!



Integrals—to 125 horsepower

Fractionals—from 1/200 horsepower

Matched Motor Parts—for built-in applications

If it's an R&M, *it's the Right Motor!*

Get This Helpful Bulletin

Bulletin 455 gives details and specifications of "Motor Parts for Portable Tools." Write for a copy—no obligation, of course. Robbins & Myers, Inc., Motor Division, Springfield 99, Ohio.

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MOTOR DIVISION: SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

Fractional & Integral Motors & Generators

Electric Fans

Electric & Hand Hoists & Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment

Here is the answer to a frequent question we receive from people everywhere. Yes, Cannon *does* make a complete line of accessories to be used in conjunction with the AN Series of connectors. Complete engineering data on each of these is given in the Cannon AN Bulletin, available on request.

CANNON ELECTRIC

Since 1915

Factories in Los Angeles, Toronto, New Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Company, Dept. T-117, P. O. Box 75, Lincoln Heights Station, Los Angeles 31, California.

(*Continued from page 56A*)

systems. The catalogue presents complete data on the following distribution apparatus: distribution transformers, dry-type transformers, feeder-voltage regulators, instrument transformers, meters, instruments, capacitors, lightning arresters, fuse cutouts, fuse links, reclosers, sectionalizers, oil switches, oil circuit breakers, air circuit breakers, disconnect switches, De-ion power fuses, porcelain insulators, and street lighting. For a copy of catalogue *50-000*, contact your local Westinghouse representative.

Audio-Type Connectors. Cannon Electric Company, Los Angeles, Calif., has issued a completely revised 32-page Audio-Type Connector Bulletin (*P-4-1952*) adding new and improved connector types for microphone, public address, and low-level sound applications. This bulletin is available upon request to the Cannon Electric Advertising Department, P. O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif.

Al-Fin Molecular Bonding Process. A 16-page brochure on the process of molecularly bonding aluminum and ferrous metals has been issued by the Al-Fin Division of the Fairchild Engine and Airplane Corporation, Farmingdale, N. Y. This is the first comprehensive piece describing the process and its applications and contains several pages of basic design information. Copies of the brochure are available from the company.

Push-Button Controls. The complete Arrow-Hart line of oiltight push-button controls is described in a 12-page folder issued by The Arrow-Hart and Hegeman Electric Company, Hartford, Conn. Comprising the line are standard, extended, and mushroom buttons, 2- and 3-position selector switches, and pilots, together with suitable legend plates. Units may be mounted directly on machines or in control cavities. Copies of the folder can be obtained by writing to Industrial Control Division, The Arrow-Hart and Hegeman Electric Company, 103 Hawthorne Street, Hartford 6, Conn.

Electronic Components. A new 16-page catalog of Electronic Components has been issued by Switchcraft, Inc., 1328 North Halsted Street, Chicago, Ill. This catalogue includes many additions to the present line of components as well as new items of special interest to the electronics industry, such as adapters, shielded jacks, microphone connectors, telever switches, and cable assemblies. Copies will be sent on request to the company.

Vacuum Metallizing. "Vacuum Metallizing Today," a new comprehensive brochure, has been published by the F. J. Stokes Machine Company, Philadelphia, Pa. It describes in detail this newest low-cost coating process and how it can be applied to the surfaces of plastics, metals, glass, paper, textiles, leathers, and many

(*Continued on page 66A*)

INTERNATIONAL RECTIFIER CORPORATION

EL SEGUNDO
CALIFORNIA

HERMETICALLY SEALED
Diameter.....3/16" to 1-1/4"
Length.....9/16" to 10"
Current: half-wave..1.5 ma to 60 ma
Voltage: DC output.....20 volts to 4,000 volts

PHENOLIC CARTRIDGE
Diameter.....⅛" to 1"
Length.....½" to 12"
Current: half-wave..1.5 ma to 60 ma
Voltage: DC output....20 volts to 10,000 volts

SELENIUM DIODES
Diameter.....0.100" to 0.300"
Length.....0.210" to 0.250"
Output Voltage.....20V to 80V
Output Current...2[illegible] ua to 1.5 ma
Temperature Range ...50°C to 100°C

Selenium Rectifiers

A recent month's production included Rectifiers to supply 40 microamperes, 1,000 volts, and Rectifiers with a capacity of 140,000 amperes, 14 volts.

POWER STACK
[illegible] Kw Power
Considered to be the largest single selenium rectifier stack produced.

Owned and managed by Engineers who are specialists in the design and manufacture of Selenium Rectifiers. Submit your problems for analysis and we will be glad to offer our recommendations.

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No wonder customers say that even if Pinco products did not have so many exclusive points of superiority, Pinco nation-wide service would make it wise to buy them.

The Porcelain Insulator Corporation
LIMA, NEW YORK

Sales Agents: Joslyn Mfg. & Supply Co.
Offices in
Principal Cities

PINCO
INSULATORS

(Continued from page 64A)

other products. The basic principles are outlined and schematically illustrated in the 12-page brochure. The complete vacuum metallizing process is covered, including pretreatment, drawing of vacuum, metallizing, and finishing. Copies of "Vacuum Metallizing Today," catalogue 725, may be obtained through the F. J. Stokes Machine Company, 5500 Tabor Road, Philadelphia, Pa.

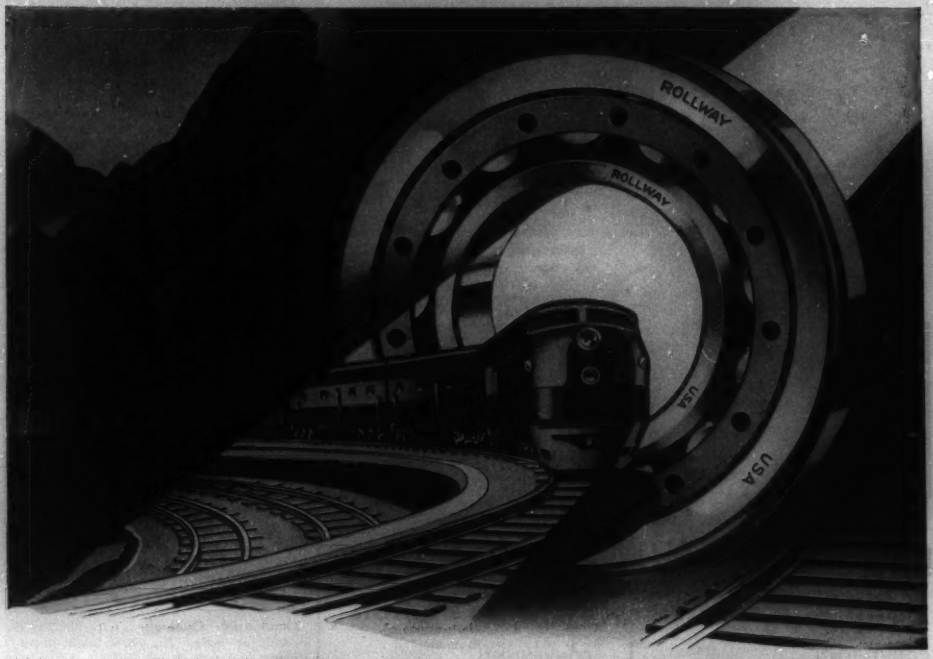
TV Tube Complement Book. A new enlarged third edition of Sylvania's Television Receiver Tube Complement Book has been published by the Radio Tube Division, Sylvania Electric Products Inc., Emporium, Pa. The new edition lists receiving and picture tube types required for nearly 4,000 different models of television sets now in home use. Television receivers are listed alphabetically by manufacturers to provide convenient reference for television servicemen when checking tube types required for a specific model and its chassis. The total number of tubes required for each chassis is also given. 120 pages. 75¢ per copy. Copies may be obtained through Sylvania Tube Distributors or direct from the advertising department, Sylvania Electric Products, Inc., Emporium, Pa.

Aircraft Electrical Installations. "Design Manual on Aircraft Electrical Installations" has been published by the Aircraft Industries Association, Washington, D. C. The manual devotes 16 chapters to such significant topics as circuit protection; circuits for essential equipment, cable selection, and routing; electric equipment selection and installation; maintenance, operation, and inspection of electric equipment; electric system tests, and others. The price of the manual is $1.00 per copy, and it is available from the Aircraft Industries Association of America, Inc., 610 Shoreham Building, Washington 5, D. C.

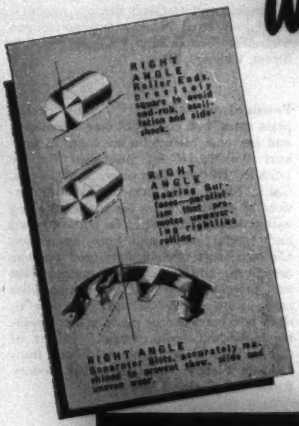
Speedomax Catalogue. "Speedomax Type *G* Instruments for Measurement and Control," a revised 48-page edition of its Speedomax catalogue, has been published by Leeds and Northrup Company, Philadelphia, Pa. To the catalogue listing of familiar Speedomax instruments for recording or control of temperature, speed, and power have been added recorders for measuring such diverse quantities as pH, daylight illumination, electolytic conductivity, and weight or other mechanical loads. Listings also include for the first time numerous Speedomax Recorders for specialized applications. A copy of Catalogue *ND 46(1)* is available upon request to Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia, Pa.

Index of Literature. Bulletin Index *700-A* is an index of technical literature available from Minneapolis-Honeywell Regulator Company, Industrial Division,

(Continued on page 68A)



When the load hits its peak...


RIGHT ANGLE Roller Ends... Precisely square to avoid end-rub, axial-location and side-shock.
RIGHT ANGLE Bearing Surfaces—parallel—that promotes unwavering rigidities rolling.
RIGHT ANGLE Separator Slots, accurately machined to prevent skew, slide and uneven wear.

. . . Rollway Bearings are still performing at *their* peak efficiency! There's no skew—no end-rub—no destructive side shock—therefore, no power loss. Rollway Bearings continue to *roll right* because they're *made right.*

On pinion and commutator ends of traction motors, the inbuilt trueness of Rollway's right angle design provides smooth, uninterrupted service. Result: fewer shutdowns for service or replacement.

Roll the RIGHT WAY with ROLLWAY

Send us your bearing problem. Our engineers will gladly make necessary calculations and drawings—supply the information required for its solution. No charge or obligation.

ROLLWAY BEARINGS

Complete Line of Radial and Thrust Cylindrical Roller Bearings

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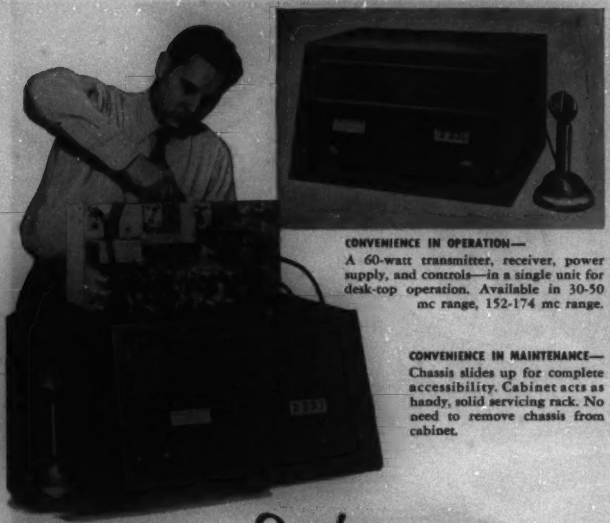

CONVENIENCE IN OPERATION—
A 60-watt transmitter, receiver, power supply, and controls—in a single unit for desk-top operation. Available in 30-50 mc range, 152-174 mc range.

CONVENIENCE IN MAINTENANCE—
Chassis slides up for complete accessibility. Cabinet acts as handy, solid servicing rack. No need to remove chassis from cabinet.

NOW see what CONVENIENCE means with RCA's new 2-way radio station

CONVENIENT!
Compact, space-saving design
Complete base station in a single desk-top unit using less than 3½ square feet of desk space—saves valuable floor space.

CONVENIENT!
Up to 3 transmitter channels, 2 receiver channels
Designed for up to 3-channel transmission and 2-channel reception where required. Lights on front panel indicate frequency in use.

CONVENIENT!
Easy to install and service
Just plug in transmission line and AC power and you are ready to operate. Lift-out chassis for servicing in cabinet. Metering plugs for easy checking.

CONVENIENT!
Local or remote operation
Choice of local or remote control base station in single, compact cabinet. Chassis also available in standard cabinet rack or weatherproof, pole-mounting box.

For further details on the new RCA 60-watt desk station, MAIL COUPON NOW

Dept. 42I, RCA Engineering Products,
Camden, New Jersey

( ) Please send me information on new Carfone desk station.

Also send me information on 2-Way Radio for:
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Organization_____

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City_____ Zone_____ State_____

RCA **RADIO CORPORATION of AMERICA**
MOBILE COMMUNICATIONS CAMDEN, N.J.

(Continued from page 66A)

Philadelphia, Pa. It consists of both numerical listing and alphabetical cross index for specification sheets, instrumentation data sheets, catalogues, and other literature. Included in the alphabetical index are articles from *Instrumentation*, the manufacturers' quarterly publication. The index is available upon request to Minneapolis-Honeywell Regulator Company, Industrial Division, Station 40, Philadelphia, Pa.

Cast-Iron Boxes for Electrical Applications. The Hope Electrical Products Company, Inc., Newark, N. J., has just issued a new 26-page catalogue on cast-iron boxes for electrical applications. The catalogue gives complete construction details and lists hundreds of standard sizes of outlet boxes and fittings, junction and pull boxes, hinged cabinets, terminal boxes, and explosion housings. It also describes and illustrates the many kinds of custom modifications which can be made in standard boxes at relatively low cost. Complete ordering instructions, list prices for standard sizes, and costs of custom modifications are included. The catalogue, designated as number *50A*, is available on request from Hope Electrical Products Company, Inc., 338 Wilson Avenue, Newark 5, N. J.

Condensed Catalogue. A condensed catalogue listing Nuclear's latest instruments and radiochemicals for radioisotope applications in the medical, educational, industrial, and research fields is available on request from Nuclear Instrument and Chemical Corporation, 229 West Erie Street, Chicago, Ill.

Powder-Iron Cores. Tuning cores, plain cores, bob cores, pot core assemblies, and cup core assemblies are listed in Lenkurt Bulletin *IC-P8*, published by the Lenkurt Electric Company, San Carlos, Calif. Illustrations, drawings, and dimensions of standard cores are included along with ordering information for both standard and special cores and core assemblies. Characteristics of commonly used powders are given, and typical performance data are presented for pot core assemblies made from three common powders to show how cores can be made to meet specific individual requirements. Copies of this bulletin are available on request from Lenkurt Electric Company, 1101 County Road, San Carlos, Calif.

Aero Test-Stands. U. S. Electrical Motors Inc., Los Angeles, Calif., has produced a bulletin telling how test-stands with variable speed can be used in testing magnetos, generators, alternators, hydraulic pumps, constant speed drives, and actuators. Dual heads are shown which enable a tester to test two components simultaneously. Graphs show comparisons of variable speed systems, load ratings, and relative speeds. The bulletin, *1749*, may be obtained from U. S. Electrical Motors, Inc., 200 East Slauson Avenue, Los Angeles, Calif.

GLASSMIKES*

the capacitors with the exclusive glass housing and plastic dielectric film

Preferred where High Temperatures, High Resistance, and Low Loss are Essential!

Glassmike capacitors are wound with the plastic film which accentuates the electrical characteristics you require, and results in capacitor design of minimum size. The metal ferrules, soldered to silver bands at each end of the hermetically-sealed glass tubes, eliminate mounting problems.

Applications:

audio and RF coupling
pulse forming and de-spiking networks
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audio frequency coupling
electronic computers
electrometer and oscillator circuits
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Send us your requirements and we will recommend the proper capacitor.

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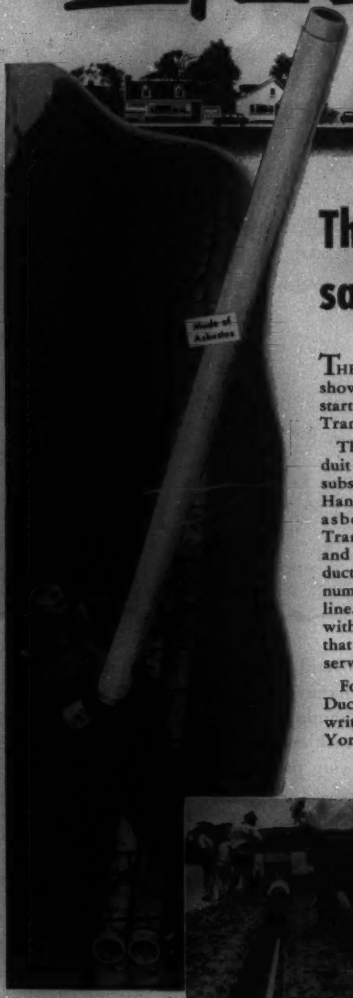
* *Glassmikes* . . . an exclusive capacitor line originally designed by our engineers

Easy to install...



That's why TRANSITE DUCTS save time, labor and money

THESE "ON THE JOB" photographs show why savings begin right at the start of the installation when you use Transite* Ducts.

The light weight of Transite Conduit and Korduct permits hauling a substantial footage of duct per truck. Handling is fast, too, because the asbestos-cement composition of Transite Ducts makes them strong and tough. The longer length of each duct . . . 10 feet . . . reduces the number of joints in the completed line. And joints are quickly made with the Transite Tapered Coupling that is engineered to stay tight in service.

For the full story of how Transite Ducts can reduce your cableway costs, write Johns-Manville, Box 60, New York 16, New York.

4 OTHER REASONS WHY TRANSITE DUCTS DO A BETTER JOB AT LESS COST:

1. Corrosion-Resistant. Transite, being made of inorganic asbestos and cement, resists corrosion and is immune to electrolysis.

2. Permanently Smooth Bore. Transite makes long cable pulls easy. Danger of damage to cables is also minimized.

3. Incombustible. Transite will not burn nor contribute to formation of smoke, gases, or fumes . . . confines burn-outs and protects adjacent cables permanently.

4. Higher Thermal Conductivity. Cables run cooler in Transite, reducing I^2R losses, increasing current capacity and prolonging insulation life.

Easy to Handle: Working in a deep trench, this man finds that the light weight of Transite Ducts helps him work without undue strain.
*Reg. U. S. Pat. Off.

Speeds Installation: Transite Ducts are joined so rapidly that the assembly man can often follow right behind the trencher . . . as shown in this installation.

Speeds Distribution: The light weight of Transite Conduit enables the contractor to haul a large number of ducts per truck and speed distribution on job site.

Cuts Manhole Costs: Concrete will be poured directly around these Transite Ducts to form the manhole wall, a time and material saving made possible by Transite's strength.

Johns-Manville TRANSITE DUCTS

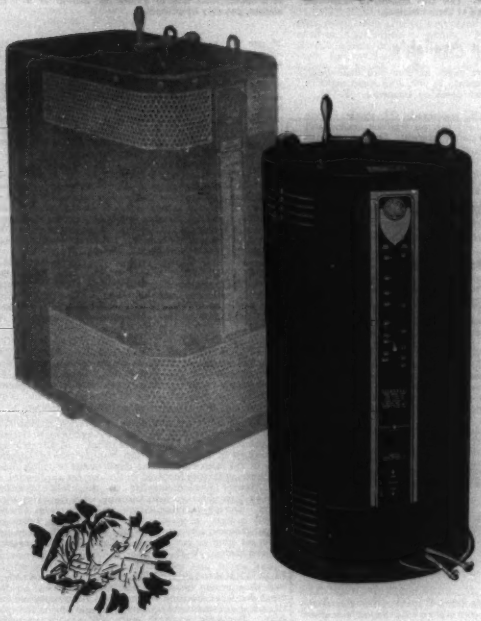
JOHNS-MANVILLE JM PRODUCTS

TRANSITE KORDUCT—for installation in concrete

TRANSITE CONDUIT—for exposed work and installation underground without a concrete encasement

HOW G-E SILICONES OFFER YOU

IMPORTANT SAVINGS THROUGH NEW DESIGN POSSIBILITIES



Lighter, more compact design! G-E silicones (resin SR-98) in Class H insulation made possible a 25% saving in critical copper in the redesign (right) of this atomic-hydrogen welder. G-E silicone insulation permits the welder to operate at higher temperatures—provides exceptional resistance to moisture and chemical fumes. Use coupon for more data on SR-98!

Here's an opportunity to save time, money and materials! Take advantage of the new design possibilities offered by General Electric silicones. For example, new Class H insulation made with G-E silicones permits drastic reductions in the size and weight of aircraft autotransformers. G-E silicone rubber makes possible longer-lasting jet engine seals, diesel gaskets and aircraft ducting.

WHAT CAN G-E SILICONES DO FOR YOU?

New design possibilities of silicones are suggested in an informative booklet *The Silicone Story*. Why not write for a copy today? In it you may find the key to improving a product or process . . . possibly even a clue to making an entirely new product! Just mail the coupon.

THE FOUR BASIC PROPERTIES OF G-E SILICONES

Inertness to metals, rubber, many chemicals
Resistance to temperature extremes
Release from sticking
Unusual surface characteristics

G-E SILICONES FIT INTO YOUR FUTURE

General Electric Company
Section 133-6 A
Waterford, New York

- ☐ Please send me a free copy of *The Silicone Story*.
- ☐ Send me product data on SR-98.

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(In Canada, mail to Canadian General Electric Company, Ltd., Toronto.)

GENERAL ELECTRIC

133-6

You'll be proud to say "I'm a BOEING engineer!"

FOR 35 years, Boeing engineers have pioneered outstanding designs for both civilian and military aircraft. During the last war, the B-17's and the B-29's dominated America's bomber fleets. Today the Air Force has an effective aerial team in the swift Boeing B-47 Stratojet medium and the new eight-jet B-52 Stratofortress heavy bomber shown above.

You'll be proud to work with the men who designed and produced these revolutionary, trail-blazing airplanes. You can join them on future work on these jet bombers — and on such challenging, long-range projects as nuclear-powered aircraft, guided missiles and other secret programs.

There are openings at Boeing right now for experienced and junior engineers in all fields, for aircraft

- DESIGN
- DEVELOPMENT
- RESEARCH
- PRODUCTION
- TOOLING

also for servo-mechanism and electronics designers and analysts, and for physicists and mathematicians with advanced degrees.

Work and live in the Pacific Northwest in Seattle, or in the Midwest in Wichita. Boeing provides generous moving and travel allowances, offers you special training and a salary that grows with you.

You'll be proud when you say, "I'm a *Boeing* engineer!"

Write today to address below or use coupon

JOHN C. SANDERS, Staff Engineer—Personnel
Dept. G-9
Boeing Airplane Company, Seattle 14, Wash.

Engineering opportunities at Boeing interest me. Please send me further information.

*Name*_____

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Engineering Societies Personnel Service, Inc.

New York 8 West 40th St. | **Chicago** 84 East Randolph St. | **Detroit** 100 Farnsworth Ave. | **San Francisco** 57 Post St.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of these advertisements, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient, non-profit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns.

Apply by letter addressed to the key number and mail to New York Office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription rate of $3.00 per quarter or $12 per annum, payable in advance.

Men Available

ELEC ENGR; 30 yrs exper in elec pub util—distr, constr, opers, management; 16 yrs Latin Amer exper in Portuguese and Spanish speaking countries. E-676.

ELEC ENGR, MS EE, registered; 27, single; 2 yrs with large elec machinery mfr on training course and des; 4 yrs teaching all power courses. Desires pos with future either teaching or indus. Location preferred, West. E-677-518-C-f-San Francisco.

LATIN AMERICA. Elec Engr available for assignment in Latin America. Command of Portuguese and Spanish. Grad engrg degrees and 8 yrs indus exper in electro-mech controls, instrumentation, communications, television; age 34. E-678.

Positions Available

ENGINEERS. (a) Project Engineers, electrical, electronic or mechanical graduates, qualified to direct development, production and test programs for components of servo-mechanism systems, inductive type pressure transducers and miscellaneous rotating a-c equipment (miniature). Will be given responsibility for the coordination of design layout, production engineering and manufacturing liaison for instruments and other devices not now in production. Salary, $6000–$7500 a year. (b) Project Engineers, electrical, electronic or mechanical graduates, qualified to direct development, production and test programs for resistance type pressure transducers, accelerometers and miscellaneous instruments. Experience with Bourdon tube, diaphragm or anfroid capsule pressure measuring devices and wire wound card or mandrel resistance coils. Will be given responsibility for the production engineering and re-design of existing instruments as well as the development of new products. Salary, $6000–$7500 a year. Location, New Jersey. Y-6717.

STAFF ASSISTANTS, under 45, electrical graduates, with some electrical distribution system design engineering experience, but who are primarily experienced or interested in the operation and maintenance of electric distribution systems. Should have four years' utility experience. Salaries open. Location, Long Island, N. Y. Y-6720.

ENGINEERS. (a) Electrical Engineers for electrical control and application work on d-c paper machine drives, a-c finishing machine drives, a-c general equipment drives, general controls, motor generator sets and industrial lighting. Work experience in the above essential. Salary, $4800–$7200 a year plus all employee benefits. (b) Electrical Engineers for power distribution work in planning and laying out a complete primary and secondary distribution system and helping supervise the installation. Work experience in above essential. Salary, $4800–$7200 a year plus all employee benefits. Location, Pennsylvania. Y-6870.

ASSOCIATE PROFESSOR OR FULL PROFESSOR in electrical engineering, with Doctor's degree preferred; five years' college teaching experience; will be required to teach advanced electrical engineering subjects in electrical engineering relative to electronics, advanced circuits, analysis or electrical machinery, power transmission and distribution. Location, Midwest. Y-6946.

ENGINEERS. (a) Telephone Equipment Engineers, B.S. in E.E. or M.E., 22–40, with two years' experience with central office switching equipment, preferably step-by-step. Knowledge of telephone switchboard equipment for manufacturer of telephone equipment. Salary, $3900–$5400 a year. (b) Telephone Design Engineers, B.S. E.E. or M.E., 22–40, with two years' experience in the application of relays, stepping switches, and similar components to a wide variety of electrical control circuits and apparatus. Knowledge of telephone equipment. Designing of control circuits or in the determination of relay characteristics to meet conditions of use for a manufacturer of telephone equipment. Salary, $3900–$5400 a year. Location, Illinois. Y-6986-R-8120.

SALES ENGINEER, electrical graduate, with experience, to sell industrial control, magnetic relays, including hermetically sealed telephone type, fluorescent ballasts, oil burner ignition and neon sign transformers, special magnet coil forms and similar devices. Straight salary with merit increases. Company car furnished. Location, northern New Jersey. Y-7000.

ENGINEERING INSTRUCTION. (a) Instructor or Assistant Professor to teach direct current circuits and machinery and magnetic circuits and alternating current circuits, class and laboratory. Salary, $3400 for nine months. (b) Instructor or Assistant Professor to teach courses in electrical machinery. Should have some industrial experience. Salary, $4800 a year and up. Location, upstate New York. Y-7056.

CHIEF ENGINEER, 40–50, with at least five to ten years' experience in charge of design, product development in business machine field. Must have some knowledge of electronic control apparatus. Salary, $12,000–$15,000 a year. Location, Brooklyn, N. Y. Y-7139.

INSTRUCTOR OR ASSISTANT PROFESSOR, electrical graduate, Master's degree in electronics, and preferably one or two years' teaching experience, for small department in University in New England. Y-7157.

SALES TRAINEES, graduates in electrical engineering or in engineering and business management preferred, for manufacturer of storage batteries. Applicants will be trained in the factory in the manufacture of batteries and in the sales engineering department learning those engineering factors involved in the correct application of the battery engineeringwise to the field program. Would then undergo field training with the sales engineers. During training salary would be from $3000–$3600 a year, plus traveling and business expenses. When assigned a territory, would be on basic salary and expenses plus a commision. Territory, northeastern United States. Y-7173.

ELECTRICAL ENGINEER, 30–40, capable of design and to supervise installation of major electrical equipment for large housing units. Will be responsible for electrical maintenance as well. Single status for one year. Two-year contract with 3½ months vacation leave at end of contract. Salary, $6900–$7800 a year, plus room and board; plus $125 a month allowance for married man, plus $25 per month for each child. Location, Foreign. Y-7175.

CHIEF PRODUCT ENGINEER, electrical or mechanical, with ten years' experience in electronic computers, radar or fire control for electronic instrument manufacturer. Salary, $12,000–$15,000 a year. Location, East. Y-7198.

ELECTRICAL ENGINEER with two to three years' experience, preferably with electrical control manufacturer, for staff consultation in the selection and installation of electrical equipment relating to rubber process industry. Some traveling. Salary, $6000 a year. Headquarters, New York, N. Y. Y-7207.

ELECTRICAL ENGINEER with electronic control and industrial equipment experience, for test and development of ordnance materiel. Salary, $6000 a year. Location, eastern Pennsylvania. Y-7225.

SENIOR DEVELOPMENT ENGINEER, electrical graduate, with at least five years' radio communication experience covering design and development of aircraft receivers. Salary, $8000–$10,000 a year. Location, northern New Jersey. Y-7238.

ENGINEERS. (a) Field Test Engineer, electrical, to supervise field tests on installed electrical equipment of all sizes and ratings, including motors, control, switchgear, transformers and synchronous condensers. Will be responsible for safety of equipment and personnel as well as co-ordination with construction forces, architect engineers and operating organization. Tests include ratio and phase angle measurement, dielectric strength tests, mechanical checks, as well as operational checks. Registered professional engineer preferred. Salary, $7500 a year. (b) Estimating and take-off man, electrical, with broad background in heavy electrical construction. Must be able to make accurate bills of materials from engineering drawings and write clear, concise specifications for procurement of electrical material

NOTE: Closing date for material to be set in the classified advertising column, as well as cancellations for running ads, must be received not later than the first of the month preceding issue; i.e., July first for August issue.

and equipment. Salary, $7200 a year. Location, Tennessee. Y-7244.

ELECTRICAL ENGINEER, 40–50, graduate, with experience in the actual design and in the direction of design by others, of all types of lighting and power systems for buildings, including electrical distribution systems. At least five years' of experience must have been in charge of other designers. Work will require a knowledge of the economics of wiring systems and a practical knowledge of specifications with the ability to write specifications on all types of electrical systems. Salary, about $8000 a year for regular time plus compensation for overtime. Location, New York, N. Y. Y-7291.

ASSISTANT PROFESSOR in electrical engineering, with at least a Bachelor's degree in the field of electrical power machinery. Salary, $3800 for nine months. Location, Virginia. Y-7351.

ELECTRICAL ENGINEER, maintenance, for work involving the supervision of men on maintenance and operation of high and low tension substation equipment. Some experience desirable. Salary, to start, about $5100 a year. Location, Ohio. Y-7358.

ENGINEERS. (a) Electrical Engineer, 25–35, B.S. E.E., with three to five years' experience in design or development of fluorescent ballast, for national manufacturer of quality specialty transformers. (b) Electrical Engineer, 25–35, B.S. E.E., for neon-ignition transformer design. Three to five years' experience in the design and development of either neon or ignition transformers. (c) Electrical Engineer, 25–35, B.S.E.E. or M.E., with electro-mechanical background for solenoid development of solenoids. (d) Electrical Engineer, B.S.E.E., 30–40, with at least three years' in responsible position as project or development engineer, with experience in at least three of the following lines: fluorescent ballast, luminous tubes, mercury vapor, ignition, power circuit, control and radio transformers. Will be head of development section. (e) Electrical Engineer, 25–35, B.S. E.E., for radio, TV and radar transformer design. Three to five years' experience in development and design. Salaries open. Location, Midwest. Y-7388.

SENIOR ELECTRONIC ENGINEER, 28–38, engineering degree, with five to ten years' laboratory and development experience in design and analysis of advanced electronic circuits in connection with the fields of radar systems, instrumentation, computers or communications. Should be able to apply fundamental principals of engineering and mathematics to the solution of original technical problems of more than average difficulty. Experience in managing or supervisory work an asset. Salary to $12,000 a year depending upon experience, plus share in profits plus additional 25% for overtime. Location, New York. N. Y. Y-7390.

ENGINEERS. (a) Senior Electrical Design Engineers electrical graduates, preferably 35–45, experienced in design of steam and hydro plants and substations. (b) Assistant Electrical Design Engineers, graduates, with minimum of five years' experience in design of power stations and substations. (c) Junior Electrical Design Engineer, graduate, with minimum of two years' experience in design of power stations and substations. (d) Electrical Draftsman with two years' or more experience, to design substations, power plant, switchboards and facilities. Some foreign travel; knowledge of Spanish or Portuguese desirable; large consulting engineering firm in New York, N. Y. Y-7399.

ENGINEERS. (a) Electrical Plant Betterment Engineer, electrical graduate, 35–45, familiar with testing and preventive maintenance work on electrical equipment in power plants, to make surveys and reports regarding improvements in testing procedures and preventive maintenance work. (b) Junior Electrical Engineer—System Work, electrical graduate, with minimum of two years' experience with an electric utility operating company in operating, relay or equipment application work. Eventually some foreign travel. (c) Junior Electrical Engineer, graduate, for general office work in engineering department of large consulting office. Salaries open. Knowledge of Spanish or Portuguese desirable. Location, New York, N. Y. Y-7400.

ENGINEERS. (a) Electrical Distribution Engineer, graduate, 35–45, with thorough experience in overhead distribution work. Experience in underground work and transmission work will be of value. (b) Assistant Distribution Engineer, electrical graduate, with minimum of five years' experience in distribution work with a utility operating company. (c) Junior Distribution Engineer, electrical graduate, with minimum of two years' experience in distribution work with a utility operating company. (d) System Planning Engineer, electrical graduate, 35–45, familiar with economic studies of development of power stations and transmission systems. Calculating board experience desirable. (e) Assistant Relay Engineer, electrical graduate, with minimum of five years' experience with utility operating company in relay work and associated system protection and operation. Salaries open. Knowledge of Spanish or Portuguese desirable; for large consulting engineering firm in New York, N. Y. Some foreign travel. Y-7401.

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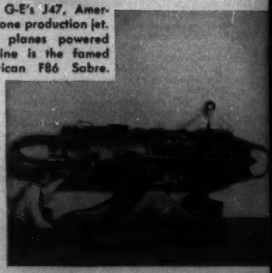

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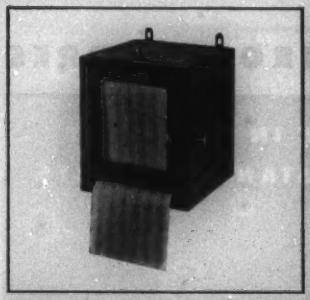

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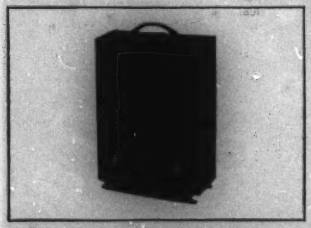

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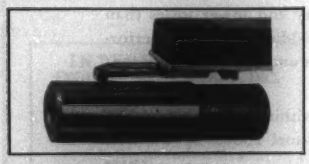

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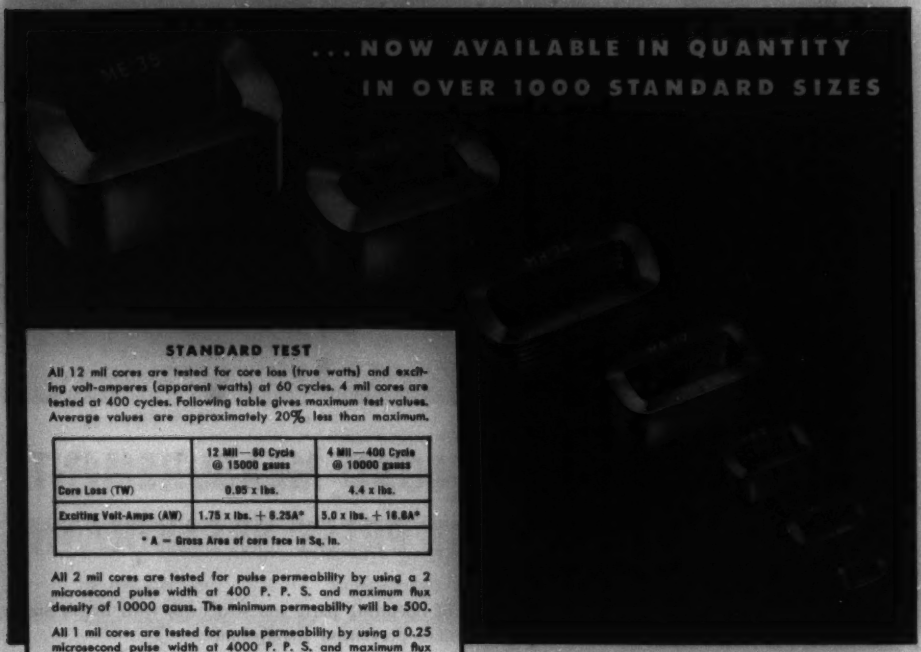

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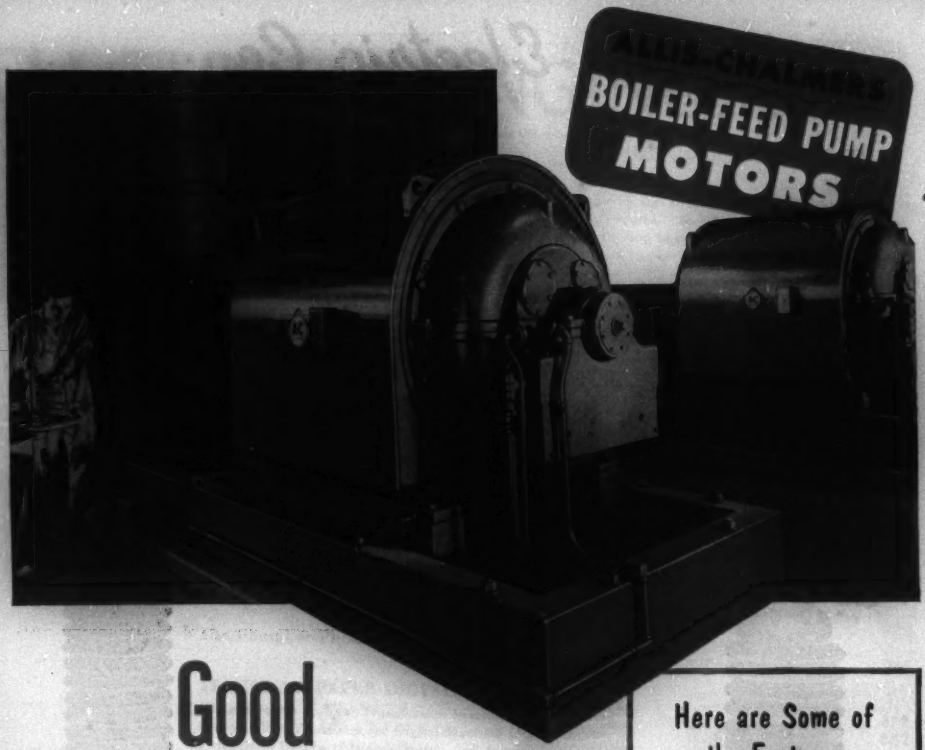

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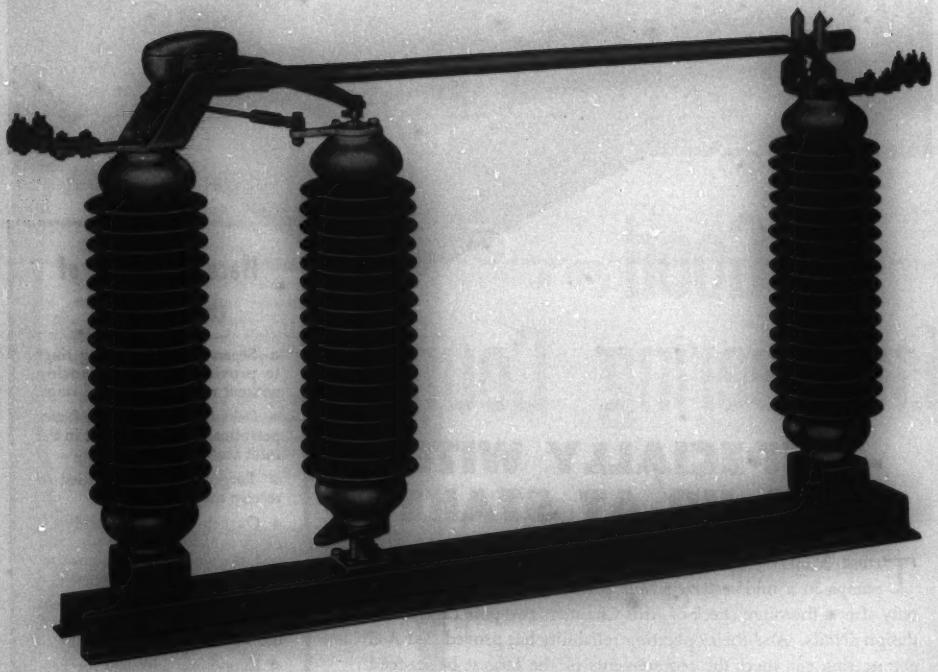

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